POWER

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Price Suicide

This is a buyer's market. Both buyer and seller are fully aware of it, but, judging by some of the transactions, the seller is apparently doing his best to keep things at their worst. Here is an illustration.

A purchasing agent was called upon to procure something for the making of which a particular manufacturer enjoyed a top-notch reputation. A price was requested with no intention of securing competitive figures. Now it so happened that other matters delayed the buyer's opportunity to place the order. And thereby the vendor became the victim of his own lack of selling courage.

He succumbed completely to a loss of faith in his own product and begged the privilege of cutting his own price. Extraordinary as it may seem, the seller lowered the value of his own commodity three times before he allowed the buyer to give him the order. Such selling tactics would be funny were they not so pathetic.

Buyers can recite innumerable instances of the kind and some even less creditable to the selling psychology. No purchasing agent worthy of the name relishes his job under such conditions, but it is the seller's fault — and no one else's — if the accepted figure is suicidal.

EDITORIALS

Power Economics

Those familiar with and interested in the question of purchased or made power are no doubt aware of the strong influences that seasonal power and heating requirements in office buildings have upon economic studies to determine whether one can better supply his own heating and power needs or purchase them from existing agencies. There are many cases where power and steam requirements during the summer season decline to such an extent as to completely reverse the apparent economics when judged by the winter load requirements alone. It is also clear that any circumstance tending to raise the power load requirements during the summer months will necessarily make it worth while to reconsider the relative economics of purchased and made power.

A factor which bids fair to bring this about in many cases is air conditioning. The remarkable impetus in this branch of industry during the past year indicates that before long conditioned air will be a necessity for hotels, office buildings, theatres, restaurants, schools, hospitals, colleges and in fact all manner of buildings where people gather or spend a very large portion of their lives.

The need for conditioned air is, if anything, more apparent as a summer requirement than during the winter, although it is equally important at all seasons. The particular thing is that it does give indication of creating a summer power load in numerous institutions and edifices, the existence of which may effectively alter the power and heat economy in many instances. Engineers and owners will do well to watch the growth of air conditioning from this viewpoint as well as the others that may more obviously suggest themselves.

Charging Rent for Stack Space

Is the rentable value of stack space a proper charge against steam production in office buildings, hotels and similar structures? This question is asked more frequently than formerly in districts where central steam is in competition with private boiler plants. While the economic principles involved in an answer are simple, their application to specific cases has caused some confusion.

At the start it is important to distinguish between an existing building with an adequate stack and a building not yet beyond the stage of architect's plans. In the case of the existing building with stack the owner cannot rent the stack space unless he first goes to the expense of removing the stack and of shifting certain interior walls on every floor. Even then he may in some cases merely increase the size of lobbies and corridors already amply large. If the owner can foresee any actual increase in obtainable rental for the building, he must deduct from this, to get the net gain, the fixed charges on the stack removal and other necessary alterations.

If, on the other hand, the problem of purchasing or making steam comes up for consideration before building construction is started, it is reasonable to expect that the omission of the stack will permit certain changes in the building design and that these will either insure a slightly greater total rental for a given building investment or permit a slight reduction in total first cost for the same rental value. Here is an engineering problem that requires the honest and intelligent cooperation of the architect or building expert in its solution.

In some cases, bias for or against purchased steam has undoubtedly influenced the evaluation of stack space. Sound power economists must insist on the facts and the facts only. In their presence many an argument will melt away.

What the Practical Man Wants of the Theorist

Not so long ago practical men poked fun at theories and theorists. Today one hears less of it, perhaps for the simple fact that much theoretical work has proved itself extremely practical in its final results. Radio and a variety of electrical devices are outstanding examples. In the power field, high-tension transmission, the regenerative cycle, high-pressure steam plants, the steam turbine, modern steam engines, fans and pumps, would not exist in their present forms if the theoretical steps in their development had been omitted. So much on the credit side of the theory ledger.

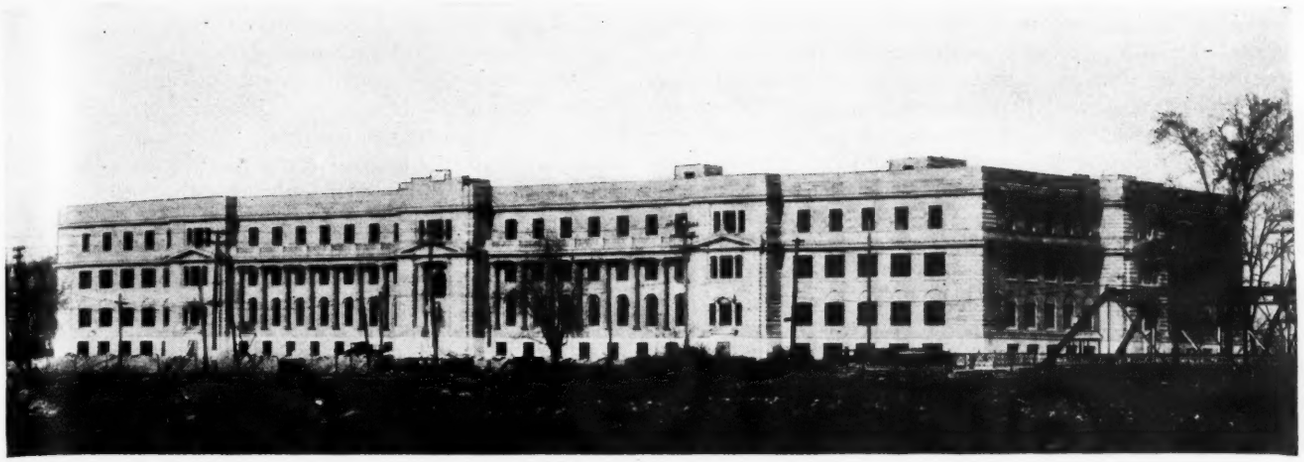
On the debit side is the hocus pocus—often unsuspected by its very practitioners. Granting the theorist's right to work in his own way and with his own familiar tools, how can he justify the elaborate terms with which he presents his benefactions? Why does he not make more attempt to translate his findings into the language of the man who might use them? Some suspect him of the tricks of the professional magician who keeps up a patter to prevent his audience from seeing how the wonder is performed.

There may be something in this suspicion. Or it may merely be that the average theorist lacks the time or ambition to finish his job. Whatever the reason it will do no harm to pass along the tip that the abiiity to speak and write simple english is no discredit to a man who spends most of his time delving in thermodynamics and differential equations. He is the better man who can deliver as well as create.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



New Building in which Canada's national research activities will be centered

CANADA BACKS RESEARCH WITH $3,000,000 BUILDING

By E. G. WILSON
Ottawa, Canada

Canada will soon dedicate a new $3,000,000 laboratory building in Ottawa in which will be centered the research activities of its National Research Council. Other buildings house a hydraulic testing tank 400 ft. long, an internal-combustion engine testing laboratory and a wind tunnel. Future plans include constructing a hydraulic laboratory on the site of a hydro-electric plant now part of the laboratory's property

CONSTRUCTED in Ottawa, at a cost in excess of $3,000,000, the new research laboratories of the National Research Council of Canada is an imposing structure and represents the nation's most ambitious scientific undertaking. The building, containing approximately 250,000 sq.ft. of floor space, is 418 ft. long, 176 ft. wide and 60 ft. high. It is of steel-frame construction faced with Wallace sandstone brought from quarries in Nova Scotia. As the structure has been erected for purposes of research it is, generally speaking, a system of laboratory units, with accommodation on the main floor for the Council staff. There is also provision for a research library with 300,000 volumes.

Built in the form of a squared figure 8, the building has two inner courts. Eventually they will be used for research museums and exhibition halls. In that section of the building running from front to rear between the courts are housed the scientific research library and an assembly hall that is expected to become the gathering place of scientific men from all over Canada.

Space has been provided for various departmental laboratories of the Government. One such laboratory to be located in the new building will be that of the Gas and Electricity Inspection Service, Department of Trade and Commerce.

Almost the entire rear portion of both the basement and first floors will be occupied by the engineering physics laboratories. Here the testing machines and cranes that require a high ceiling will be located. The crane in the hydraulic and thermo-dynamic laboratories will be of 15 tons' capacity. In the electrical laboratories will be apparatus capable of testing up to 600,000 volts or more.

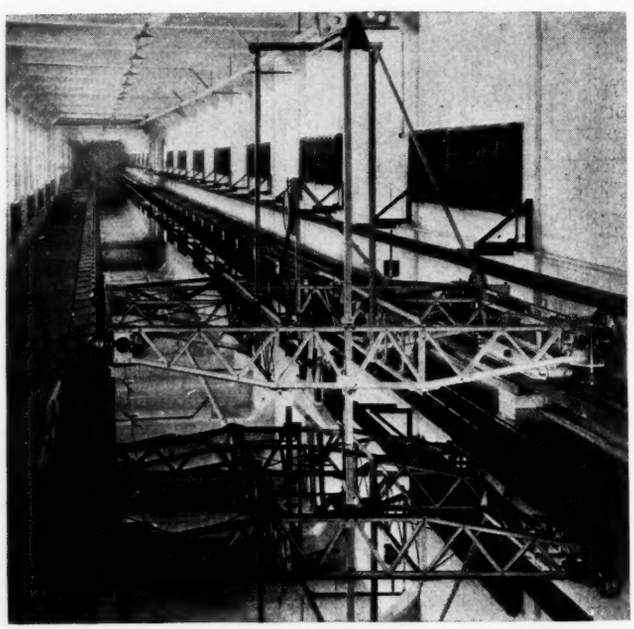
Throughout the other portions of the building are what are called unit laboratories, 12 ft. by 20 ft., separated by temporary partitions that may be removed without breaking into the walls of the building, to accommodate the various types of work that the future will bring. In the northwest end of the building are the electrical laboratories and other branches of the Division of Physics and Engineering. In the southwest are the various activities of the Division of Pure and Applied Chemistry and on the top floor the Division of Economic Biology and Agriculture.

Power is supplied to the laboratory building from a 11,000-volt three-phase system, the transformers being located in an underground vault near the heating plant. Investigations showed that it would be impracticable to provide direct-current to the new building from the Council's hydro-electric plant at Rideau Falls, now being used to supply power for the testing tank for pontoons and other hydraulic devices. While the project has been abandoned for the time being, it is probable that in the near future a hydraulic laboratory will be built on the site of the hydro-electric plant.

Research Laboratories Annex

In a group of buildings known as the National Research Laboratories Annex a program of investigation has been started in the fields of aëronautics, chemistry, physics, textiles and electrical and physical standardization. The units of outstanding interest now housed in the annex are:

1. A wind tunnel for aërodynamic research and testing, 9 ft. in diameter, in which a 13-ft. propeller can develop an air speed of over 125 miles per hour.



Tank 400 ft. long, 8 ft. wide and 6 ft. deep in which floats, current meters and other hydraulic devices may be tested. The carriage is automatically controlled and will not require an observer to ride on it

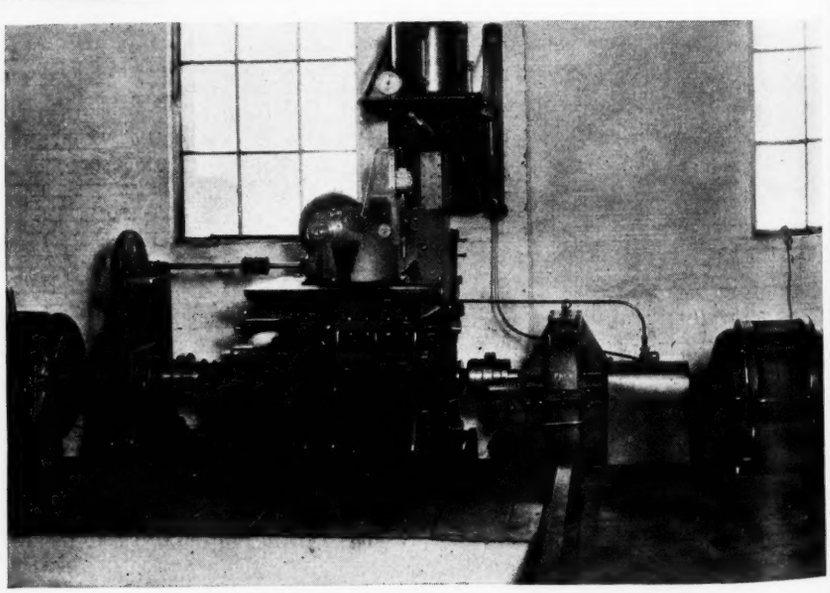
2. A towing tank for testing floats, hulls and other high-speed craft and current meters.
3. An internal-combustion-engine testing plant.

An electrical machine room is provided at the propeller end of the wind-tunnel building. Power at 2,200 volts from the Council's hydro-electric plant is supplied to the main motor-generator set. This set comprises a 760-hp., 2,200-volt, 3-phase, 60-cycle synchronous motor and a 2,200 amp., 250-volt, variable-voltage, direct-current generator together with necessary exciters. The set is started by semi-automatic starter and may be stopped by push button from any one of a number of stations. Between generator and propeller motor the current passes through a control panel. The propeller motor is of the shunt type with commutating poles and has a continuous rating of 600 hp. at 1,000 r.p.m. A speed range from less than 100 to the overload maximum of 1,075 r.p.m. is provided. In addition, a 50-hp. induction motor, variable-voltage, direct-current generator set is provided for supplying current for testing model propellers in the tunnel.

Hydraulic Test Tank

It was necessary to compromise on the dimensions of the hydraulic test tank. Fortunately, the decision was somewhat simplified in that a building, or rather two buildings, were available on the site of the laboratories, which with comparatively little alteration, could be converted into a single building 410 ft. long. The cross-section is 18 ft. wide by 16 ft. high. This building is of reinforced concrete and brick construction. Bedrock, most important in the case of a test tank of this kind, is but a few feet below the surface. The tank is 400 ft. long, 8 ft. wide and 6 ft. deep.

The carriage runs on 80-lb. railroad rails carried on H-beams which in turn rest on the cast-iron caps on concrete piers extending above the tank sides. As the speeds provided for in the design are too high to permit of securing the necessary acceleration by traction between steel wheels and steel rails, the carriage is drawn along the tank by steel cables. The arrangement is somewhat similar to that on a traction elevator, using steel cable passing around a driving sheave at one end and an idler sheave at the opposite end of the tank. The driving

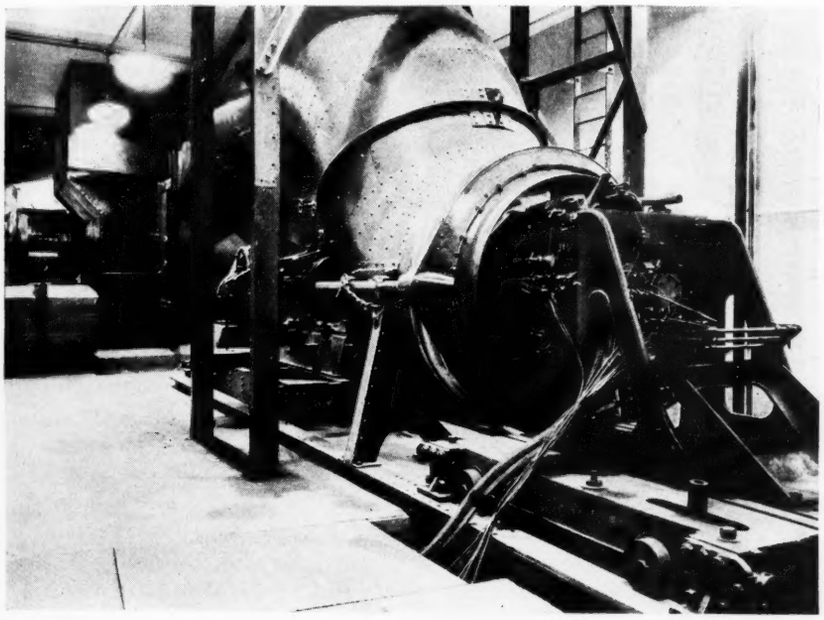


Drive for the towing carriage on the hydraulic testing tank consists of an induction motor connected through a reduction gear to a hydraulic variable-speed transmission. The carriage is driven by cables running over a sheave on the output shaft of the variable-speed transmission

sheave is driven through a speed reducer and variable-speed gear by an induction motor. Automatic control for the driving system will regulate the car's speed during acceleration, constant-speed run and retardation. As the records will also be obtained automatically, it will not be necessary for an observer to ride on the carriage.

Engine-Testing Plant

A complete internal-combustion engine testing plant has been installed capable of accommodating aircraft engines of any type, air- or water-cooled, absorbing up to 1,000 hp. at speeds up to 2,500 r.p.m. For testing air-cooled engines, a large centrifugal fan, driven by a 250-hp. motor, discharges a blast of air through a cylindrical duct and adjustable nozzle, past the engine cylinders. Air speeds up to 130 mi. per hour are obtainable. There is also in the laboratories a small single-cylinder unit for testing engine fuels in which routine tests of fuels are made and laboratory investigations of detonation carried on.



In this laboratory internal-combustion engines of sizes up to 1,000 hp. at 2,500 r.p.m. can be tested

To carry on its work the National Research Council has gathered in Ottawa a professional and administrative staff of 119, and it enjoys the voluntary assistance of more than 300 scientific men and representatives of industry in various parts of Canada who serve on the Council's associate committees. In addition, under the Council's assisted-researches program 100 skilled investigators in universities and other laboratories of the Dominion have been set to work at a minimum of expense on special problems of scientific and industrial importance.

Work of the Research Council

Canada inaugurated her national research movement as a result of a lesson learned in the early years of the war. At that time Germany's supremacy in the application of science was driven home, and Great Britain and the Dominions fully realized the importance of scientific research. This led to the formation of the National Research Council, under the presidency of Dr. H. M. Tory of the University of Alberta. That was in 1916, but it was not until 1929 that laboratories were developed in the group of buildings, formerly used as a lumber plant and now known as the annex.

But the interval between 1916 and 1929 was by no means one of inactivity for the Council. Lacking its own laboratories, it concentrated during those first years on encouraging researches carried on in established institutions for the solution of industrial problems. This was done by money grants for the purchase of equipment not otherwise available and the employment of assistants. About $100,000 was expended on research in this way in 1929, enabling the carrying out of approximately 100 important research projects in various parts of Canada.

Briefly, the purpose of the National Research Council is threefold: (1) To conduct researches, to promote the use of the natural resources of Canada and to improve the technical processes in use in her industries, while developing processes which may induce development of new industries. (2) To assist and direct similar researches carried on in other laboratories, either industrial or at Canadian universities. (3) To stimulate interest in scientific research and develop a body of trained technicians and scientists by means of scholarships. In addition, it has the important functions of determining standards and methods of measurement, standardizing scientific and technical apparatus for the Government service and private industries, and determining standards of quality used in construction of public works.

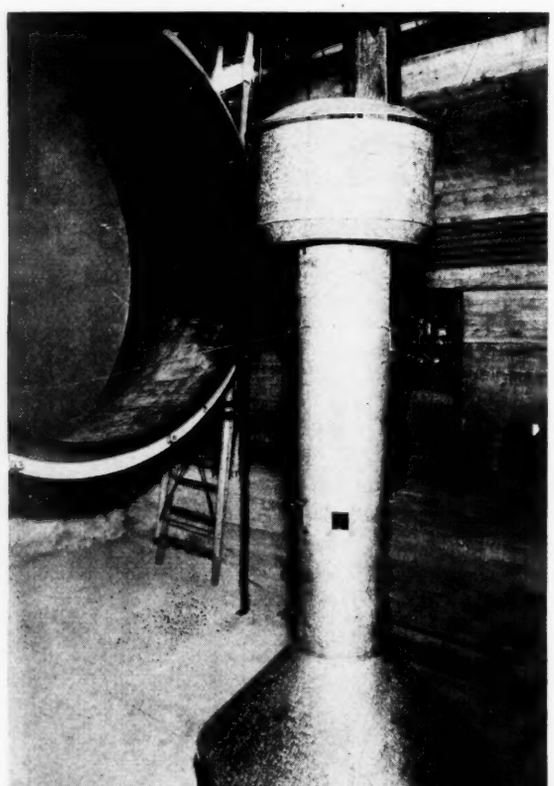
Quite a remarkable reaction from the depressed state of industry during the past year was the increased demand made upon the Council's laboratories. Never before had the officers of the Council received so many requests for assistance in the utilization of waste products, the standardization of products, and in other efforts of economy and efficiency. In the minds of those who conceived the National Research Laboratories has been the idea that in them could be combined the principles on which the United States Bureau of Standards and the Mellon Institute have operated; that is, they would be prepared to conduct researches of general public interest and therefor at the full expense of the Dominion, and researches of more restricted and special benefit at the expense of private companies who would contribute to the cost of the work or have their research investigators work on their problems in the national laboratories. During the past year the interest of a number of companies in the latter plan has been shown. The contributions toward the expense of one group of researches has been doubled by those interested. One of the Maritime Provinces recently signified its intention to place an investigator in the Council's laboratories at its own expense.

There are undoubtedly many technical problems peculiar to Canada alone which can most effectively and most economically be solved by a laboratory cooperating with industry and utility alike. But research in the

National Research Laboratories will not be confined to those problems peculiar to Canada only; the laboratories will embark on an extremely broad program of research in electrical engineering.

In anticipation of this broad program every reasonable effort is being made to provide adequate services for investigating any problems that may arise. In the installation of services in the laboratory attempt has been made to provide those which will be of greatest general use, making provision at the same time for the future installation of more as time and finances permit and as the demand for them is created.

Space for electrical engineering research has been set aside at one end of a very modern laboratory, roughly 30 ft. wide, and having a headroom of approximately



A ventilator being tested in the wind tunnel, where air velocities up to 125 mi. per minute may be obtained

28 ft. Off this space are a mezzanine floor and smaller units which will be devoted to some of the less cumbersome investigations and to office space for calculating, etc. Separate workshop facilities will be provided. Steam, air, water and other services are available and in the immediate future the following electrical services will be available:

1. Direct current at variable voltage up to 240 volts.
2. Sixty-cycle alternating current at variable voltage up to 1,100 volts single- or three-phase.
3. Twenty-five cycle alternating current at variable voltage up to 1,100 volts, single- or three-phase.
4. Variable voltage from batteries for special work requiring extremely steady currents.

In the case of the alternating currents the frequency may be varied somewhat and it is expected to increase the voltage range for both alternating and direct current. The present tendency toward high-voltage analysis has not been overlooked and plans are being made for high-voltage equipment, probably up to 750,000 volts, with a possible capacity of 400 kva. While this range is rather modest, it is the maximum which can be installed in the available space and undoubtedly will prove valuable for many investigations. It is hoped that at some future time a higher-voltage laboratory can be installed in an isolated building specially designed for the purpose.

To the electric-meter industry the Research Council has a special and definite close relation, for in addition to the duty of fixing and maintaining electric standards, the Council has the further duty imposed on it of approving or disapproving all types of meters used in Canada for the purchase and sale of electrical power. In the Dominion electricity inspection service for electric meters approximately 300,000 meters are checked each year.

The headquarters and Ottawa laboratory of this service will move into the new Research Council building, where suitable space is now prepared and equipped for it. In the past, this service, in carrying out its public duties, has endeavored to assist in development work on meters when the manufacturers so requested. In future it will be a duty of special research workers of the Council's technical staff to aid in this work. Consequently there will be in the new building an electrical-meter research laboratory, equipped for the accurate determination of all electrical quantities and for the accurate determination of the characteristics and possible error in any type of meter or other electrical-measuring instrument.

Electrical Standardization

The National Research Council has properly maintained standard cells, potentiometers, bridges, shunts, multipliers and other equipment to do standardization work in the field of measurements on direct current and at commercial frequencies. This includes the standardization of voltmeters, ammeters, wattmeters, watt-hour meters, reactive meters, shunts, resistors or multipliers, bridges, potentiometers and standard cells of the saturated type. The Council can also determine conductivity, electrical-temperature coefficients and similar characteristics.

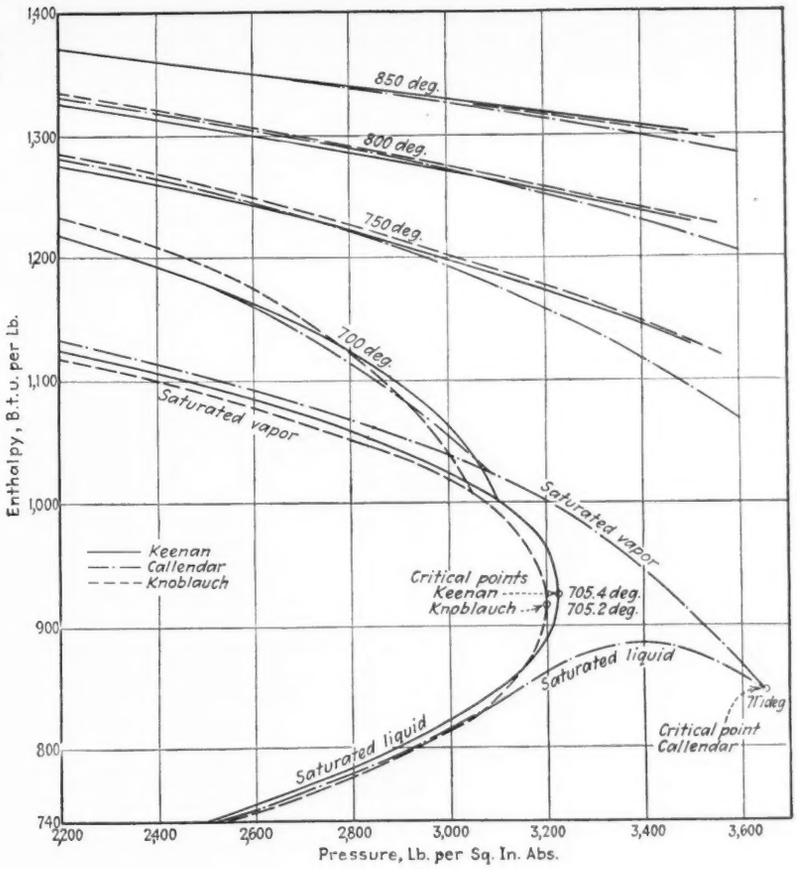
Provision is being made for complete equipment to calibrate instrument transformers, and the Council is at present in a position to test current transformers up to 500 amp. and potential transformers up to 6,000 volts. These ranges will soon be extended.

Provision was made for workshops in the plans of the main laboratory building, but with the construction of the laboratories in the Annex more shop accommodation became necessary and it was considered advisable for economy and ease of administration to concentrate the shops for all the laboratories in one location. By making use of a suitable existing building to enclose these services an important saving was effected.

The building contains metal- and wood-working shops, and a drafting room. The metal-working shop is well equipped with an assortment of machine tools for general and precision work, together with sheet-metal working tools, welding and heat-treating equipment.

During the last year work has been actively carried on with regard to the use of magnesium compounds in the manufacture of refractory brick, some of this work being done by the staff of the Associate Committee on Magnesite in the Ceramic Laboratories of the Dominion Department of Mines.

Comparison of Keenan, Callendar and Knoblauch values for enthalpy in region of critical point



A COMPARISON OF RECENT STEAM TABLES

By
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DURING the past ten or twelve years marked increases have taken place in the pressures and temperatures used in steam power generation. In 1920 the maximum pressure in power station practice was 300 lb. per square inch. This was raised to 350 lb. per square inch in 1923, and the following year plants designed for 650 lb. were under construction. By 1926 the maximum steam pressure had been raised to 1,200 lb. per square inch and there are now several central stations operating with pressures of about 1,400 lb. During the past four or five years special types of high-pressure steam generators have been under development both in this country and in Europe, some of these being designed to produce steam at pressures above the critical.

Steam temperatures have increased from about 600 deg. F., in 1920 to over 800 deg. at the present time, with a few European stations operating at 900 deg. and one large public utility in this country has an experimental installation designed to generate and use steam at 1,000 deg.

Need for New Steam Tables

The steam tables of ten years ago were satisfactory for pressures up to about 350 lb. per square inch. A few of these tables covered the entire range of pressures up to the critical, but the lack of experimental data at the higher pressures made for a considerable amount of disagreement and uncertainty. The rapid increases in pressures and temperatures for a time outstripped the progress in steam research, and designers of steam power equipment found themselves without adequate data covering the fundamental properties of steam.

To remedy this situation the American Society of Mechanical Engineers undertook, in 1921, a definite program of steam research. At about the same time Prof. H. L. Callendar[1], in England, began a research project covering the higher ranges of pressures and temperatures. He was aided by the British Electrical and Allied Industries. In Germany a research program of similar scope has been in progress for a number of years. It has been promoted by the Verein deutscher Ingenieure and the Notgemeinshaft der deutschen Wissenschaft and has been mainly under the direction of Dr. Ing. Knoblauch.

Work on New Steam Tables in the United States and in Europe

Beginning in 1922 the steam research work in the United States was carried on simultaneously at three institutions: the United States Bureau of Standards, Massachusetts Institute of Technology and Harvard University. The experimental work at Harvard was completed by 1925 but the work at the other two institutions is still in progress. In 1927, using the data available by that time, Prof. J. H. Keenan undertook the work of formulating a steam table to extend to 3,500 lb. and 1,000 deg. The work was completed in 1929 and resulted in the Keenan Steam Tables and Mollier Diagram which was published in 1930. In 1929 Professor

[1]Since Professor Callendar's death in January, 1930, his research is being carried on by Professor Edgerton assisted by the former's son, G. S. Callendar, who is doing the experimental work.

TABLE I — COMPARISON OF RECENT TABLES FOR SATURATED STEAM

I — International mean value — 1930.
Ke — Keenan tables, interpolated — 1930.
C — Callendar tables, interpolated — 1929.
Kn — Knoblauch, Raisch, Hausen & Koch — 1932.

Temp. F.		Abs. Press. Lb. per Sq.In.	Int. Toler. ±	Total Enthalpy. Mean B.t.u. per Pound: Sat. Liquid (h_f)	Int. Toler. ±	Evap. (h_{fg})	Sat. Vapor (h_g)	Int. Toler. ±
392 (200)	I.	225.6	0.14	366.2	0.18	833.9	1200.1	4.5
	Ke.	225.5		366.3		833.0	1199.3	
	C.	227.4		366.5		838.4	1204.9	
	Kn.	225.5		366.2		833.2	1199.4	
482 (250)	I.	557.5	1.42	466.4	0.90	737.3	1203.7	7.2
	Ke.	577.1		467.4		735.2	1202.6	
	C.	582.1		467.5		744.7	1212.2	
	Kn.	576.7		466.4		734.7	1201.1	
527 (275)	I.	863.3	1.42	520.0	1.8	678.3	1198.3	9.0
	Ke.	863.2		523.1		671.5	1194.6	
	C.	868.5		522.0		685.3	1207.3	
	Kn.	862.3		519.8		674.4	1194.2	
572 (300)	I.	1247.4	1.42	579.4	3.6	602.7	1182.1	9.0
	Ke.	1247.2		583.2		596.1	1179.3	
	C.	1249.0		580.3		613.7	1194.0	
	Kn.	1246.4		577.9		601.9	1179.8	
617 (325)	I.	1749.4	1.42	647.7	5.4	509.2	1156.9	10.8
	Ke.	1750.6		648.7		506.0	1154.7	
	C.	1744.1		645.3		522.3	1167.6	
	Kn.	1749.4		644.1		509.2	1153.3	
662* (350)	I.	2399.4	2.13	726.9	9.0	379.7	1106.6	14.4
	Ke.	2401.3		729.6		376.0	1105.6	
	C.	2384.0		724.0		392.7	1116.7	
	Kn.	2398.6		723.3		376.1	1099.4	
700	Ke.	3096.4	....	846.3	....	156.9	1003.2	....
	C.	3099.0		833.5		188.7	1022.2	
698	Kn.	3050.4	....	824.1	....	181.7	1005.8	....
705.4	Ke.-1931	3211.6	....	924.8	....	0	924.8	....
706.1	Ke.-1930	3226.0	....	925.0	....	0	925.0	....
	C.	3246.3		875.8		116.1	991.9	
705.2	Kn.	3201.0	....	915.8	....	0	915.8	....
710	C.	3350.0	....	883.2	....	84.3	967.5	....
717	C.	3650.0	....	846.0	....	0	846.0	....

* Upper limit of 1930 International tables.
Temperatures in parentheses are in degrees centigrade.

Callendar published his "Extended Steam Tables" covering pressures up to 4,000 lb. and temperatures up to 850 deg. The latest steam tables to come from Germany are those of Knoblauch, Raisch, Hausen and Koch. They were published early in 1932 and extend to 250 kg. per square centimeter (3,556 lb. per square in.) and 550 deg. centigrade (1,022 deg. F.).

In order to secure better coordination of research activities in the different countries an international steam table conference was held in London in 1929. At this meeting a skeleton steam table was made up, consisting of what appeared to be the most probable values at that time. Plus or minus tolerances were inserted in this table, it being agreed that any investigator's data which came within the tolerance for that portion of the table would be considered worthy of recognition.

A second international conference was held at Berlin in 1930 at which time the skeleton table was revised in accordance with the progress made since the previous meeting. It is expected that a third conference will be held in this country early next fall. The International Skeleton Table of 1930 extends to 350 deg. centigrade for saturated steam and to 550 deg. centigrade and 250 kg. per square centimeter for superheated steam.

Comparison of New Tables

To make a comparison of recent tables the International Skeleton Table of 1930 was converted to English units. By interpolation and conversion of units, where necessary, the corresponding values were then obtained from the Keenan, the Callendar, and the Knoblauch tables. The results of this comparison for saturated steam are shown in Table I, while Table II gives a similar tabular comparison for superheated steam.

It may be seen that Callendar's values for saturated steam are definitely above those of the International Table while those of Keenan and Knoblauch tend to be lower. Of the three sets of data only that of Knoblauch is within the International tolerances over the entire range. The 1930 International Tables for saturated steam extend only to 662 deg. F. Above that temperature the amount of disagreement becomes greater due to the increased difficulty of making accurate measurements near the critical point. Two Keenan critical points are shown, that for 1931 being the one given in the Keenan Compressed Liquid Water Table published in February of that year. Keenan and Knoblauch are in fairly close agreement as to the critical point, but Callendar places it at a considerably higher pressure and temperature and finds an enthalpy of vaporization of 116 B.t.u. at the temperature of the Keenan critical point of 1930.

In making a comparison for superheated steam it is seen that Keenan and Knoblauch are both in fairly close agreement with the International Table, Keenan's values being somewhat high for the higher temperatures. The Callendar values are above those of the International at the lower pressures and temperatures, but fall below them in the higher ranges. In general the agreement for superheated steam is better than that for saturated steam.

The curves give a comparison of the three tables with respect to the pressure-enthalpy relationship for the higher range of pressures and temperatures. Saturated liquid and saturated vapor lines are shown as well as comparative isotherms at 700, 750, 800 and 850 deg. F. It is seen that at 850 deg. there is quite close agreement up to a pressure of about 2,800 lb. per sq.in. Beyond that point the Callendar data show a more rapid decrease of enthalpy with increase in pressure. The 800-deg. and the 750-deg. isotherms show the Callendar values above those

TABLE II — COMPARISON OF RECENT TABLES FOR SUPERHEATED STEAM (Mean B.t.u. per pound)

I — International mean value — 1930.
t — International tolerance (plus or minus)
Ke — Keenan tables, interpolated — 1930
C — Callendar tables, interpolated — 1929
Kn — Knoblauch, Raisch, Hausen & Koch — 1932
Temperature — degrees F.

Pressure Lb. per Sq.In.		482 (250)	572 (300)	662 (350)	752 (400)	842 (450)	932 (500)	1022 (550)
355.6 (25)	I.	1239.7	1294.6	1345.0	1394.5	1442.1	1488.9	1536.6
	t.	3.6	3.6	3.6	3.6	3.6	4.5	5.4
	Ke.	1238.3	1293.1	1343.7	1393.4	1442.2	1490.8	1538*
	C.	1246.6	1299.8	1350.0	1397.3	1444.1	1489.7	.....
	Kn.	1238.5	1293.5	1344.2	1393.7	1442.5	1490.9	1539.5
711.2 (50)	I.	.....	1259.5	1320.7	1376.5	1427.7	1479.9	1530.3
	t.	.....	5.4	4.5	4.5	4.5	4.5	6.3
	Ke.	.....	1258.4	1319.8	1375.7	1428.9	1481.2	1533*
	C.	.....	1264.4	1324.7	1378.8	1429.3	1477.6	.....
	Kn.	.....	1259.0	1321.9	1377.4	1430.6	1482.3	1513.3
1422.3 (100)	I.	.....	.....	1262.2	1336.0	1399.0	1457.4	1513.2
	t.	.....	.....	5.4	4.5	4.5	4.5	7.2
	Ke.	.....	.....	1260.4	1333.9	1399.9	1461.7	1520*
	C.	.....	.....	1266.3	1339.6	1400.2	1454.9	.....
	Kn.	.....	.....	1265.0	1338.0	1401.5	1460.3	1516.8
2133.5 (150)	I.	.....	.....	1166.8	1286.5	1365.7	1433.1	1494.3
	t.	.....	.....	7.2	4.5	4.5	4.5	7.2
	Ke.	.....	.....	1167.3	1283.0	1368.2	1441.6	1507*
	C.	.....	.....	1166.2	1289.0	1367.1	1430.7	1487*
	Kn.	.....	.....	1166.8	1287.7	1368.2	1434.0	1495.8
2845.0 (200)	I.	.....	.....	.....	1216.3	1326.1	1407.1	1475.4
	t.	.....	.....	.....	4.5	5.4	7.2	10.8
	Ke.	.....	.....	.....	1219.4	1330.6	1420.3	1493*
	C.	.....	.....	.....	1215.8	1326.8	1403.6	1466*
	Kn.	.....	.....	.....	1222.6	1329.9	1405.3	1473.4
3556.0 (250)	I.	.....	.....	.....	1121.0	1277.5	1376.5	1452.0
	t.	.....	.....	.....	7.2	9.0	9.0	18.0
	Ke.	.....	.....	.....	1126*	1289*	1396*	1478*
	C.	.....	.....	.....	1091.0	1275.3	1374.8	1461*
	Kn.	.....	.....	.....	1124.4	1284.0	1373.4	1448.4

* Extrapolated values.
Pressures in parentheses are in kilograms per square centimeter.
Temperatures in parentheses are in degrees centigrade.

of Keenan up to about 2800 lb., but again with a more rapid decrease at the higher pressures. At 3,500 lb. per square inch and 750 deg. Callendar's value for enthalpy is about 40 B.t.u. below that of Keenan.

At 700 deg. Keenan and Callendar agree up to about 2,500 lb. per square inch. Keenan's isotherm then proceeds with a greater amount of curvature which throws it above Callendar's most of the remaining distance to the saturation line. The Knoblauch 700-deg. isotherm is considerably above those of both Keenan and Callendar up to about 2,800 lb. It then falls at a more rapid rate than either of the other two.

The saturation lines of Keenan and Knoblauch agree reasonably well and their critical points are fairly close together with only two-tenths of a degree difference in temperature and 25 lb. difference in pressure. Callendar is in distinct disagreement, placing his critical point at 3,650 lb. per square inch and 717 deg. F. In addition, Callendar reverses the curvature of the saturated liquid line beyond 3,200 lb. so that the two curves become tangent at the critical point instead of meeting to form a smooth curve of parabolic form as do those of Keenan and Knoblauch.

The critical point is usually considered as that pressure and temperature at which the meniscus disappears when a liquid is confined in a transparent tube and heated. Callendar found this phenomenon to occur at about the same temperature and pressure as is shown by the critical points of Keenan and Knoblauch, but claimed to be able to detect a difference in density of the liquid and the vapor above that point on up to the critical point which he indicates. He later made direct calorimetric measurements of enthalpy in this region which, he claimed, verified his first observations.

Much valuable research in steam properties has been completed in recent years and further search for new knowledge in this field is still in progress. Better agreement among the different investigators is being brought about each year and it may be expected that within a short period of time no differences of importance will exist among the several tables. The data now available appear to be amply accurate for present requirements in steam power practice. Further increases in pressures and temperatures will no doubt demand a somewhat greater refinement in steam table values.

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Operating and Maintenance Pointers on Evaporators

By HARRY M. SPRING

THE USE of the high-pressure evaporator is constantly increasing for make-up in central stations and for process steam in industrial plants. Its use in the latter case is especially advantageous, as it permits a closed cycle resulting in minimum feed-water treatment and lowered boiler maintenance.

While the evaporator is in operation periodic tests of concentration should be made to determine the proper intervals between blowing down. The maximum allowable concentration will, of course, vary with the type of evaporator, pretreatment of make-up water and other such factors that may be present in each installation.

Scale on the coils is removed by thermal expansion and contraction due to sudden temperature changes when blowing down and refilling. Such scale drops to the bottom of the shell and passes out the blowdown.

A surface blowdown gives good results in removing scum and other surface impurities from the water. This should be tapped into the shell at the average water level. This line should discharge into some waste vacuum line having a higher vacuum than the evaporator. A condenser tail water line, sump well pump suction, etc., make suitable discharge points for the surface blowdown.

At least three pressure gages should be used with the single-effect evaporator. A gage calibrated higher than the maximum steam pressure to the coil should be connected at the supply end of the coil. Two compound gages should be connected, one at the vapor outlet from the shell and one tapped into the top of the shell or the safety valve nipple.

As it is common practice to have an internal purifier for the vapor, the pressure differential may be noted by the reading of the two compound gages. In some cases carryover by foaming has occurred in spite of the purifiers. A rectangular baffle plate of sheet steel placed in a horizontal position under the purifiers has largely eliminated this difficulty.

After a number of weeks in operation, and a differential of more than 10 per cent of the maximum operating pressure is noted, it will be necessary to clean the purifier. It may be removed from the shell and scraped by hand, but this is a long job in a large evaporator. It has been found that most solids in these purifiers are soluble in hot water. The easiest method of cleaning the purifier is as follows: The float valve on the water supply is blocked open and the evaporator filled with water. The vapor discharge and blowdown lines are closed. Steam is then passed through the coils and the water in the shell is allowed to boil about fifteen minutes, with a line from the vapor discharge to the sump open. As the water boils out this line to the sump, fresh water is admitted to keep the purifiers under water at all times. The shell should then be drained, refilled and boiled out a second time. After this is done it may be drained, filled to the correct operating level and placed in service.

Probably the best method of controlling the output of an evaporator is to have the coils discharge through a drainer, and control the steam to the coils by a pressure regulator. Thus a constant output is assured even if the supply pressure is variable.

When blowing down, the method usually employed is to shut off the water to the shell, shut the steam supply valve and shut off the vapor discharge line. Live steam is then admitted to the shell by a high-pressure line tapped into the top. As soon as the shell pressure builds up to about 50 per cent of the safety valve setting, the blowdown valves are opened. An indication of the shell being empty is a sudden drop in the pressure on the compound gages. This is caused by the loss of the water seal on the blowdown line and the steam passing out. A small quantity of water is then admitted to the shell to flush it out, and this is blown out. The evaporator is then filled to the correct operating level and placed in service in the usual manner. When filling, water should be admitted as rapidly as possible, to cause a maximum contraction in the coils.

An evaporator should be drained and refilled after standing idle for over eight hours. If this is not done the action of the water on the scale will have raised the concentration so that foaming or carry-over are likely.

PATENTS

and How They Are Procured

By KARL FENNING

Professor of Patent Law, Georgetown University
Formerly Assistant U. S. Commissioner of Patents

Use of the terms "patent applied for" or "patent pending" on a manufactured article has no legal standing. It is merely a gratuitous notice to the public. The inventor has no right until the patent is issued.

THE PURPOSE of the patent system is to procure for the public information on new, improved devices and operations A patent is a monopoly, not in the sense that the owner takes away from the public something which the public already has, but when a man makes an invention, he produces something that is entirely new, and which the public might never have but for his activity in inventing it. In order to prevail upon him to disclose his invention the Government says that it will give to him for a limited period a monopoly on the thing that he has produced, as being new. He must give a sufficient description of his invention to make it possible for any one, after his patent expires, to make and use that invention. Therefore, under the patent system nothing is taken away from the public. On the other hand, much is gained, the idea being merely a contractual relation between the Government and the inventor.

The machinery by which this is accomplished is carefully provided for by the Patent Statutes. To that machinery have been added the rules of practice of the Patent Office, and, of course, in the 140 years that the patent system has been in existence many court decisions have fixed much of the details of procedure.

Procedure in Filing an Application

One of the best ways to understand how the Patent law functions is to follow the procedure that the inventor must go through in securing a patent. First, he must file an application in the Patent Office. I say "he" because the statute definitely says that the inventor must file the application. This means that you can not, although you may have something absolutely new, get a patent for it unless you are the inventor. You can not overhear something, you can not learn incidentally, you can not learn honestly, something and apply for a patent on it. The application must be filed by the inventor himself. But the inventor may assign that application when once filed to whomever he wishes; and the patent actually issues to the man to whom he assigns the patent. The application consists of three steps, first of which is the formal petition addressed to the Commissioner of Patents, in which the inventor identifies himself, says he has made an invention and would like a patent on it. There is then what is technically referred to as the specification and claims, accompanied by drawings. That is a careful description of the invention, indicating primarily what the invention is, what its purpose is, and then, in more or less elaborate detail, a review of the particular things which are necessary to carry out that invention. This is the description, the thing that the public wants. It wants to know what the inventor has invented, so that after the monopoly expires the public can use it. It is likewise essential for the public to know, while the monopoly is alive, what it cannot use, so that this description—the specification as we call it in the application—is accompanied by a set of claims, one or several hundred. Fortunately, generally there is a small number. Each of these claims sets out in brief the particular phase of the new invention on which the inventor wishes a monopoly. The specification itself is a description which goes to the public after the monopoly. The claims are the things that determine the monopoly, the things that the inventor keeps from the public, and if the inventor has described in his specification ten things, and in his claims only nine, that tenth thing presumably he dedicates to the public, and the public is free, even during the monopoly, to use that part of his invention.

Defining the Inventor

Then follows the oath, in which the inventor swears that he is the inventor and that the invention has not been in public use, and a number of other characteristic things which the statutes provide must exist before the invention can be patented. In other words, if a man makes an invention and uses it for upwards of two years publicly, the presumption is he does not want a patent on it. Hence, when he files the application he must swear that he has not used it publicly for the two-year period.

Much difficulty has arisen as to just who the inventor is. It is easy enough to say, when a man works privately and secretly, quietly in his own home, in his own laboratory, in his own shop, or entirely within his own mind, that he is the inventor. When, however, he has assistants, employees, or associates, working with him, it may be very difficult to determine who makes the invention.

One of the difficulties, therefore, with the patent system at the present time is that sometimes a patent which is a good one, which gives disclosure and everything the public wants, fails to protect the inventor because some one has made a mistake in applying for the patent, by having all the inventors, or not having one of the inventors apply for the patent. That more frequently happens when a man makes an invention and goes to some one in the early stages and says, "I wish you would put up some money to start the invention going." Under those circumstances it is not at all uncommon for the inventor and the man who puts up the money to have agreed that they would both apply for the patent. That makes the patent no good at all.

A patent is granted for 17 years. This period is arbitrary and was fixed more or less by compromise.

The function of the Patent Office is to issue the patent, but it must first determine whether the patent may properly be issued. In other words, the examination of the application at this stage consists of two parts: First, to see that it is in proper form; second, that there is an invention involved. The Patent Office is divided now into 63 divisions, each consisting of a chief and several assistant examiners. To each division is assigned certain specific types of inventions. In each of these divisions each assistant is more or less a specialist and the case will be placed on his desk and he will do the actual work of examining and determining whether a patent should issue.

Examiners Have Complete References

In order to tell whether an invention is new it is necessary to know what is old, so each of the examiners has in his files a complete set of United States patents that have been granted relating to his individual subject. In addition, we have an exchange with most of the foreign countries and procure copies of foreign patents. These are classified and assigned to the proper divisions, so that an assistant has before him, not merely all patents relating to his subject, but all foreign patents. There are many patents taken out in the United States which are taken out all over the world, and there are many taken out in one country only. Furthermore, most of the assistant examiners have something of a library of magazine literature or textbooks relating to their individual subjects. Of course, in some subjects there are very few textbooks, and on some subjects the textbook is the chief source of information upon which they rely.

After the examination has been made the examiner writes a letter to the applicant or to his attorney, making such objections as he thinks necessary, and if, as is generally the case, he finds objection to some of the claims he cites a number of patents that he has found in his search, and says that those patents limit the invention more than the inventor thinks it is limited. This is technically referred to as rejection. By statute the inventor is then given six months to reply to that letter. He replies to the letter, sometimes amending his application and changing his claims. Or, he may present an elaborate argument, saying, "No; those patents which you found do not meet my invention, and therefore you should grant the patent."

When a reply is made to the Patent Office, the examiner may have to make another search. That takes additional time. Correspondence goes back and forth, and the case may be dragged out in that way.

An application, while it is pending in the Patent Office, is kept secret, the theory being that the inventor has offered to give to the public information, but he makes that offer only on the consideration that he receive a patent. Therefore, until the patent is granted his offer is kept secret.

He secures no right by filing the application, except what is known as a technical reduction to practice. That is, in law, if he makes an invention and files a complete description this has the same effect towards perfecting his invention as if he had actually built and operated the machine. If he puts the words "patent applied for" or "patent pending," on what he makes, that has no legal standing whatever. It is merely a gratuitous notice to the public. He has no right until the patent issues.

Aside from classification, the Patent Office, a great many years ago, when smaller, published digests of patents. That is, in the weekly Official Gazette there was published a part of a drawing and a little statement of what the invention consisted of. Now a drawing and a claim is published.

The inventor's right to the 17 years' exclusive use does not begin until the termination of the proceedings in the Patent Office. The day the patent issues the patent is dated. He gets a monopoly for 17 years from that date. If a man wishes to delay his application in the Patent Office and does delay it for a year, then he has postponed the time when the public gets the right to the invention. If he delays for 5 or 10 years, as frequently happens, he has postponed it so much longer. It has been suggested that a patent should be dated either the day the application is filed, so as to make a man hurry it through the Patent Office, or some subsequent date before the issuance of his patent.

Finally, when the examiner and the inventor have reached a conclusion, the patent is allowed. That does not mean a patent issues. A notice of allowance is issued, which merely states that the Patent Office is satisfied that the patent should be granted, but the statute provides that within six months the applicant must pay an additional final, or printing, fee of $25. If he pays that fee—and it is increased if he has more than 20 claims—within the six months' period, the patent issues. If, however, he does not pay it within the six months' period, he has another six months in which he may refile or renew his application, paying again an original filing fee, and then the application will be delayed further, possibly by additional examination.

A patent is a monopoly, it is the right to exclude others from the use of a patented invention. A patent gives no one the right to manufacture anything. Everyone has a natural right to manufacture anything if he doesn't interfere with the right of someone else, but if, for illustration, one man is granted a patent for a book in which the leaves are sewed together at the back, he is the only one who can exclude everybody from making a book in that particular way. Now, if an improvement comes forth, which is a book sewed in the back, and with a hard board binding to it, that is an improvement over the general idea of sewing it together, because it has the hard board binding. The man who gets the patent on that

hard board binding can prevent everyone, including the original inventor, from using the hard board binding, but the original inventor who has the sewed book patent can prevent the other man from making any book at all with a sewed back, with a hard board binding or not. So when the patent issues the Patent Office makes no effort to determine whether the invention which the man describes will infringe an earlier patent. It frequently happens that a man has a patent that he thinks he has a right to go ahead on and may have a right to go ahead on, and some one who has something previous to him sues him and endeavors to prevent him from manufacturing, so that a true monopoly disappears to some extent.

Patent Interference Explained

One of the principal causes for delay in the Patent Office is the so-called interference procedure. Of the 70,000 or 80,000 patents filed every year there are from 3,500 to 4,000 inventions involved in which the right is claimed by two or more individuals. Where an interference is declared between two inventors, each is allowed to file an affidavit as to when he made his invention, and how he proceeded with it. Then each party is given the right to offer testimony to prove his case, to show who was the first inventor, and to show what each one did. After that is done, he has an opportunity to be heard in the Patent Office before an examiner of interference, who determines on the evidence which he thinks is the first inventor, and awards the patent to him. This is often a rather difficult procedure. An interference is litigated in the Patent Office, but the testimony is taken wherever the inventor happens to be.

The Right of Appeal

In ordinary cases the application is allowed by the primary examiner. If it is not so allowed there is the right of appeal. When we come to interference, if a patent is granted to A, B has the right to appeal. Both these claims go to a board of appeals. On that board the commissioner and three assistant commissioners and nine examiners-in-chief function; that makes a group of 13, three of whom sit at a time. They are all appointed by the President and confirmed by the Senate. From the Board of Appeals the appeals go, both on patentability and on priority, to the Court of Customs and Patent Appeals, a court in the city of Washington established under the customs act which was originally to take care of customs appeals, but which takes jurisdiction now also of patent and trade mark matters.

If, however, instead of appealing to the Court of Customs and Patent Appeals the parties may institute an original equity suit in a United States Court. In an ex parte case—that is, where it is merely a question of patentability—that will be instituted in the District of Columbia against the Commissioner of Patents who will defend the equity suit. If, however, it is an interference case, the litigation may go to the district court of the United States wherever the defendant lives, and testimony may be taken all over again, although the Patent Office testimony may be used in that litigation. But the entire matter will be litigated again to determine who was the prior inventor.

In an interference case the Patent Office is not a party; that is between the inventors. The Patent Office does not deal with any questions of infringement whatever. That is a question for the United States district court after the patent issues.

There are two provisions for correcting issued patents under the statute, a provision for disclaimers, which provides that if a man through error or mistake has claimed more than his invention, he may come into the Patent Office and disclaim part of his invention. If he has 10 claims he may say, "Claim 9 is not my invention, and therefore I desire to get rid of it."

Limits of a Reissue

In addition to that, if a man has by error, accident or mistake, claimed more than he should, or made some error in his application, he can apply for a reissue. A reissue contemplates a new application entirely, possibly new drawings, possibly new specifications. The limits within which he can change, of course, are very narrow. He can not get an entirely new patent, but if he has made an honest mistake it can be corrected by a reissue, and that is examined by the Patent Office promptly; and when it is allowed it is issued immediately, but the period of protection under the reissue is not 17 years, but the unexpired portion of the 17 years which is left from the original patent.

Now as to the matter of actual manufacture. Let us assume that a man, having made his invention, having gone through the Patent Office, or even before going through the Patent Office, proceeds to build and sell his invention, or build and use it. A patent monopoly relates to three things—the making, the selling and the using. Either one of those three is an infringement on the patent. If you make an automobile, you infringe the patent, if you sell an automobile, you infringe the patent; if you use an automobile, you infringe the patent.

Suppose a man manufactures and sells his own invention for which he has a monopoly. Let us assume that that invention is an improvement on some man's prior patent, and an infringement on the prior man's patent. There is then ground for an infringement suit. The early statutes gave the United States courts jurisdiction on the law side, but since 1819 the United States district courts have had jurisdiction of that litigation on both the law and the equity sides.

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New Steel Flooring

DEVELOPMENT of a new steel flooring has been announced by Mellon Institute of Industrial Research, Pittsburgh, Pa. This flooring consists of slabs, 24 in. wide and up to 12 ft. 5 in. in length at present, that are fabricated by preforming two steel sheets and subsequently welding them together in the plane above the neutral axis. A cross-section taken through the width of a completed unit shows four keystone-shaped cells, all connected together near the neutral axis. These four ducts which constitute each unit are spaced at 6-in. intervals, and connect directly when installed with the corresponding ducts of the adjacent section of floor slab. This arrangement enables utilization of the floor not only as a load-carrying member, but also as a multiple floor-duct system for handling electrical lines. It is said that the keystone slab can be installed with ease and rapidity; that it can be bolted, clipped, or welded into place across the structural members, affording a fire-safe, low-weight working floor.

Turbine Arrangements for Supplying Industrial Power

By WARREN B. FLANDERS
Member of A.S.M.E.

The economic possibilities of local generation of power when large quantities of low-pressure steam are required for process have been stressed frequently in *Power*. This article shows the effect of turbine efficiency on byproduct power generation and discusses various turbine arrangements

IN GENERAL, the term "byproduct power" refers to that mechanical or electrical power which may be generated from steam used in industry for heating, cooking or other purposes. In the sense that byproduct power is obtained without cost for fuel, the term is not correctly used, as each kilowatt hour generated from steam takes from the steam the heat equivalent of that kilowatt hour, or 3,412 B.t.u. divided by the electrical efficiency of the generator and the mechanical efficiency of the generator and steam turbine. Thus, this amount of heat must be supplied by the fuel in addition to that which would be required by the process steam alone. As the total will be from 4,200 to 4,800 B.t.u. per kilowatt-hour, depending on the size and type of turbines and boilers, as compared with 14,000 to 18,000 B.t.u. for the more modern central stations, the use of the term may perhaps be permitted.

An interesting feature of this industrial power is that the heat rate varies only with what may be termed the external efficiencies, which in the case of a turbine generator set are the electrical and mechanical efficiencies of the set and the thermal efficiencies of the boilers and piping. The rate is not affected in any degree by the internal efficiency or efficiency ratio of the steam turbine. Thus, a 1,000-kw. turbine generator set with a 94 per cent mechanical and electrical efficiency will take out of the steam 3,412 ÷ 0.94 = 3,632 B.t.u. per kilowatt hour generated whether the internal efficiency of energy transformation be 50 or 80 per cent.

The internal efficiency, however, does determine the amount of power that may be obtained from a given quantity of steam and is of great importance where the power requirements are in excess of the amount that may be produced from the steam available.

To illustrate these two efficiency conceptions, consider an industrial plant where 100,000 lb. of steam per hour is required for process heating. This amount of steam is assumed to be needed at 50 lb. gage pressure and 100 deg. F. superheat. With a boiler and piping efficiency of 79 per cent and 100,000 lb. of steam per hour being returned to the boiler as feed water at 212 deg. F., 1,051.1[1] B.t.u. per lb. must be added to produce each pound of steam at 65 lb. abs. with 100 deg. superheat, or 100,000 × 1,051.1 ÷ 0.79 = 133,050,000 B.t.u. per hour which must be applied from the fuel.

The electrical load is assumed as 1,000 kw. and, as stated above, this would require from the fuel 3,412 ÷ (0.94 × 0.79) equals 4,600 B.t.u. per kilowatt hour, or 4,600,000 B.t.u. per hour for 1,000 kw. Thus only 3.46 per cent more fuel is required for the process steam alone.

For an exact balance between power required and process steam, the turbine should produce a kilowatt hour on 100,000 ÷ 1,000 = 100 lb. of steam. Allowing for electrical and mechanical external losses of 6 per cent, the heat required per pound of steam would be 3,632 B.t.u. per kilowatt hour divided by the pounds of steam per kilowatt hour, or 3,632 ÷ 100 = 36.32 B.t.u., or a total heat at an assumed pressure of 200 lb. abs. of 1,231.1 + 36.32 = 1,267.4 B.t.u., which is the total heat of steam at 200 lb. abs. and 118 deg. superheat. With adiabatic expansion from 200 lb. abs. and 118 deg. superheat to 65 lb. abs., there is available 99.4 B.t.u. per pound of steam, so that the internal efficiency is 36.32 ÷ 99.4, or 36.58 per cent.

It may be noted that the heat rate per kilowatt hour is 36.32 × 100 = 3,632, i.e. the B.t.u. per pound of steam turned into work multiplied by the pound of steam per kilowatt hour, and this divided by an assumed boiler and piping efficiency of 79 per cent equals 4,600 B.t.u. per kilowatt hour from the fuel.

If the turbine engine efficiency were 74 per cent, with electrical and mechanical losses of 5 per cent, the internal efficiency would be 78 per cent. Then with 200-lb. abs. 213-deg. superheat steam expanding adiabatically to 65 lb. abs. the energy available would be 110.6 B.t.u. per pound of steam. At 78 per cent internal efficiency 0.78 × 110.6 = 86.3 B.t.u. would be taken from the initial total of 1,317.4 B.t.u. leaving a total heat in the exhaust of 1,231.1 B.t.u. The steam rate per kilowatt hour will be 3,412 ÷ (86.3 × 0.95) = 41.65 lb. The heat rate per kilowatt hour will be 41.65 (the pound of steam per kilowatt hour) multiplied by 86.3 (the B.t.u. taken from each pound of steam) divided by 0.79 (the assumed boiler and piping efficiency), or 4,550 B.t.u. This is, except for the one per cent difference in mechanical and electrical losses, the same as for the turbine whose internal efficiency is 36.58 per cent, instead of the 78 per cent just assumed.

It must be noted, however, that with the 100,000 lb. of steam per hour, the load obtained is now 100,000 ÷

[1] Steam tables by Joseph H. Keenan, 1930, are used in these computations.

41.65 = 2,400 kw. instead of only 1,000. The total additional heat required from the fuel will be 2,400 × 4,550 = 10,930,000 B.t.u. or 8.21 per cent more than for process steam alone.

It is thus clear that a supply of inexpensive power is available for use somewhere. The investment cost must of course be considered, but the cost per kilowatt of capacity will be no greater for the efficient 2,400-kw. unit than for the low-efficiency 1,000-kw. set.

Provisions for Greater Electric Load

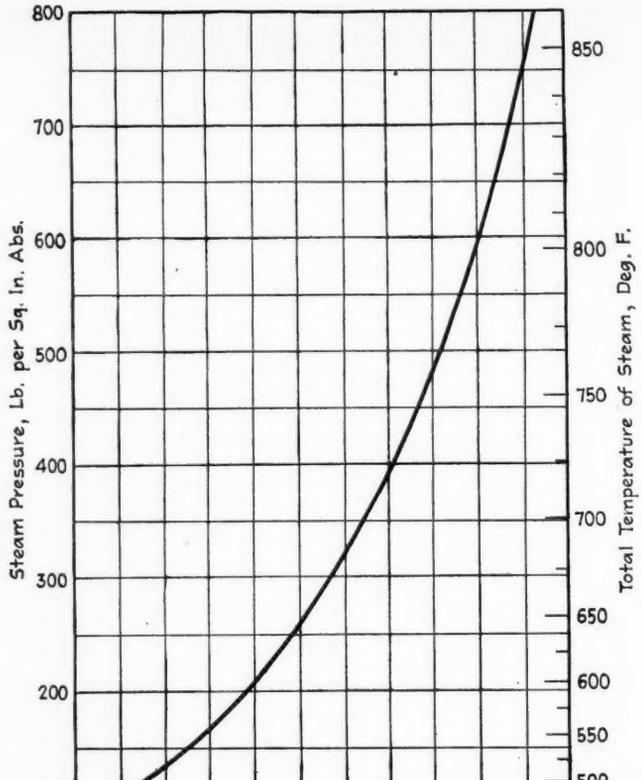
Another phase of the subject may be represented by an equal steam demand for industrial use, but an assumed load requirement of 4,000 kw. As developed above, 2,400 kw. can be obtained with a turbine generating set passing 100,000 lb. of steam per hour from 200 lb. abs., 213 deg. superheat to 65 lb. abs. and 100 deg. F. superheat. This will leave 1,600 kw. to be obtained from some other source. This may be: (a) a 1,500 to 2,000-kw. condensing unit with 200 lb. steam and 213 deg. superheat. (b) a 1,000 to 1,200-kw. low-pressure condensing unit taking steam from the 65-lb. abs. 100-deg. source. (c) a bleeder-type turbine in which the process steam passes through part of the unit and is exhausted at the required pressure, which is automatically maintained. The balance of the steam goes through a low-pressure condensing end to produce the required balance of power. (d) a higher pressure plant from which the total 4,000 kw. may be obtained from the 100,000 lb. per hour of process steam. (e) a connection to a central station distributing system.

With (a) the fuel heat rate for the additional load will be about 22,000 B.t.u. per kilowatt hour. A complete condensing plant must be installed and operated, with corresponding additions to the investment and operating costs.

With (b) a slightly better fuel rate will be obtained, as about one third of the additional load will be produced by the steam first passing through the more efficient non-condensing unit, and investment cost would likewise be somewhat reduced. The combination would perhaps be not quite as flexible as (a).

The results with (c) would be intermediate between (a) and (b) insofar as fuel consumption is concerned, but there are definite advantages in operation, cost of installation, flexibility under varying load conditions, etc. This plan will usually be found to be the most practicable of the first three.

With (d) employing higher steam pressures on the simple non-condensing turbine, to generate 4,000 kw. from 100,000 lb. of steam per hour, leaving the turbine at 65 lb. abs., and with 100 deg. superheat, the steam rate must be 100,000 ÷ 4,000 = 25 lb. per kilowatt hour. As before, this will require 4,525 × 4,000 = 18,100,000 B.t.u. per hour added from the fuel to generate the 100,000 lb. of process steam. This is 13.6 per cent additional heat above the requirements for process steam alone. The value 4,525 B.t.u. per kilowatt hour is used for this larger unit, instead of 4,550 found for the 2,400-kw. set as the mechanical and electrical losses are slightly reduced in percentage. On the other hand, while the amount of steam passing is the same, due to the higher inlet pressure the average volume is less and the internal losses are, therefore, slightly greater, offsetting the gains in external losses, so that the total engine efficiency is still taken as 74 per cent i.e. 95.5 × 77.5 for the larger unit, instead of 95 × 78 for the smaller. Note



Load in kilowatts obtainable from 100,000 lb. of steam per hour exhausting to 65 lb. abs. pressure at 100 deg. F. superheat

again that the B.t.u. rate is only affected by the external losses. The heat in the fuel per pound of steam is 18,100,000 ÷ 100,000 = 181 B.t.u. and this multiplied by 0.79, the assumed boiler and piping efficiency, is 143 B.t.u., the heat which must be added in the boiler to each pound of steam above the 1,231.1 B.t.u. required in the exhaust, or 1,374.1 B.t.u. in the inlet steam.

This 143 B.t.u. turned into internal work with an internal efficiency of 77.6 per cent necessitates an available adiabatic drop of 143 ÷ 0.776 = 184.5 B.t.u. This is also arrived at by dividing 3,412 B.t.u. by the steam rate and by the engine efficiency (internal 77.5 per cent × external 95.5 per cent of 74 per cent or 3,412 ÷ (25.0 × 0.74) = 184.5. This desired condition will be arrived at with a steam pressure of 396 lb. abs. and 278 deg. superheat, or a total temperature of 722 deg.

Again, with steam at 550 lb. abs., 310 deg. superheat (787 deg. F) and an engine efficiency of 74 per cent over-all, exhausting to 65 lb. abs. with 100 deg. superheat, there will be 222 B.t.u. available by adiabatic expansion, which at 77.5 per cent internal efficiency will turn 172 B.t.u. into work and a steam rate of 3,412 ÷ (172 × .955) = 20.8. With this rate 100,000 lb. of steam will produce 4,810 kw.

The curve shows the power that may be developed from 100,000 lb. of steam per hour supplied at different pressures, but exhausting at 65 lb. abs. with 100 deg. superheat. This curve is based on full load on turbines designed for each condition. With fractional loads the efficiency will be somewhat less and, therefore, the exhaust temperature somewhat higher.

If a higher or lower temperature be desired in the

exhaust steam, the high-pressure steam temperature should be raised or lowered about 60 deg. for each 50 deg. change in low-pressure steam temperature. Thus, if the exhaust condition desired were 65 lb. abs. with 150 deg. superheat instead of 100 deg., with 400 lb. abs. steam supply, the total temperatures should be 784 instead of 724 deg. The available energy and, therefore, the load obtainable, will increase approximately 6 per cent or 1 per cent per 10 deg. of inlet temperature.

To arrive at the approximate power for an exhaust pressure other than 65 lb. abs., but for the same 100,000 lb. of steam per hour, take the power from the curve corresponding to a pressure which is in the same ratio to 65 lb. as the desired pressure has to the new back pressure, the new pressure having the same superheat as the corresponding pressure on the curve. Thus, to estimate the power obtainable from steam expanding from 400 lb. pressure to 40 lb. abs. back pressure, the curve pressure will we $\frac{400 \times 65}{40} = 650$ lb., and the load will be 5,200 kw.; the superheat on the curve at 650 lb. is 819 $- 495 = 324$ deg., or the proper temperature at 400 lb. will be $445 + 324 = 769$ deg. Very nearly the same load would be obtained with 200 lb. steam at 710 deg. total temperature with 20 lb. absolute exhaust pressure.

With (e), a non-condensing turbine with a connection to central station power, an economical choice will depend entirely on local conditions of charges, maximum demand rates, reciprocity in power use, etc. The actual fuel consumption, taking into account line losses, etc., may perhaps be 15,000 to 19,000 B.t.u. per kilowatt hour at the industrial plant, as against the 22,000 to 28,000 B.t.u. for power generated at the plant with condensing turbines. Obviously if it were a matter of fuel consumption and plant investment only, the non-condensing turbine with the central station connection would be materially the cheapest, particularly if the industrial load makeup be considered as additional load on stations already operating, in which case their fuel consumption could be considered as 10,000 to 14,000 B.t.u. per kw.-hr.

If the process steam requirements and the load needs were fixed and constant quantities, a non-condensing turbine installation with the proper steam pressure to give the correct load would be recognized as the ideal arrangement. But at best such a plant must be designed to cover average conditions, and a greater part of the time the load requirements will either exceed or be less than that which can be produced from the process steam alone. If greater, it would be necessary to pass more steam through the turbine than could be used in the process, which is intolerable, as the fuel rate for this excess power requirement would be from 34,000 to 75,000 B.t.u. depending on the steam pressure employed. If less, process steam would be bypassed around the turbine through a feed heating desuperheater to hold the process steam temperature to that desired. This is, of course, economical as the fuel rate for all the load generated is still only about 4,550 B.t.u. per kilowatt hour, but the potential supply of cheap power is recognized and it is hard to contemplate a failure to utilize it all.

The use of separate condensing or of condensing bleeder turbines will help, but the combination of the non-condensing turbine generating set with a central station tie-in taking and giving power is so fundamentally economical and simple that it must ultimately prove beneficial to both industrial plant and utility.

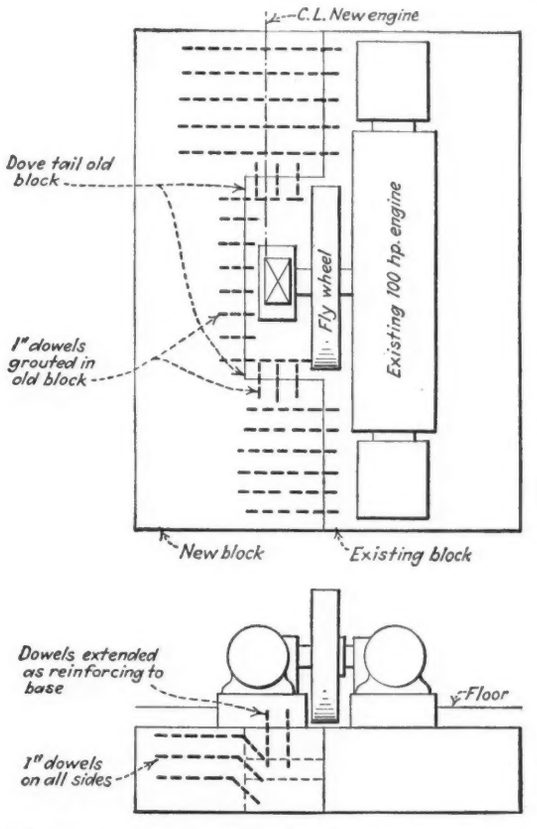
Adding 100 Hp. to Gas-Engine-Driven Compressor

By M. C. COCKSHUTT

HAVING a gas-engine-driven compressor with single cylinders direct connected and outboard bearing, we found it necessary to increase the horsepower to a total of 200 by adding another engine. The existing foundation was shaped as shown, with a piece on one side to carry the outboard bearing.

The floor was dug up all around this side and the sides of the block cleaned off by brushing with wire brushes and then roughing with an air hammer. The block that carried the outboard bearing was then cut off, after the crankshaft and flywheel had been removed.

As the extension was several feet larger than the existing block, containing about sixteen yards of concrete, it was necessary to bond them securely. A rough key, or dovetail, was cut on the concrete at the two ends of the part of the block used to carry the outboard bearing.



Method of tying new foundation to the existing block

Then holes about 2 in. in diameter were drilled at an angle on all sides of this block and one-inch steel reinforcing rods grouted in. The other ends of the rods were bent and carried up as reinforcing for the new block. When all the rods had been securely grouted in the form was built for the 100-hp. unit.

When the concrete was set the engine was skidded to place on the block and leveled with the other engine. Then the crankshaft was laid in place and carefully checked for alignment in both directions. The grout was poured under the base in the usual way.

Economical Loading of Diesel Engines

By MARTIN S. MARTIN

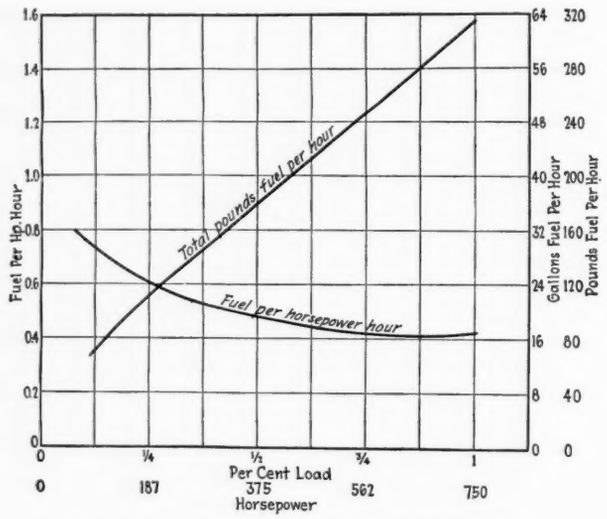


Fig. 1—Fuel consumption curve of engines

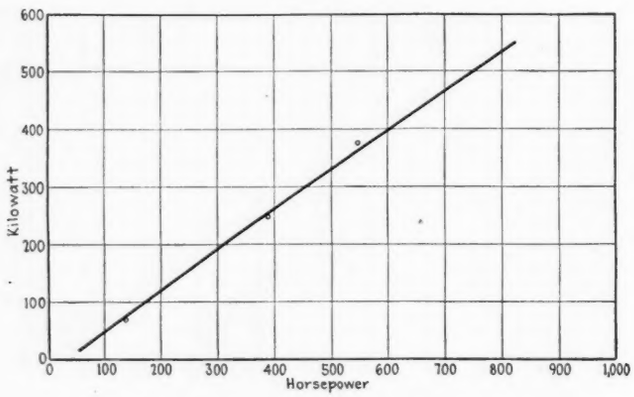


Fig. 2—Horsepower versus kilowatts

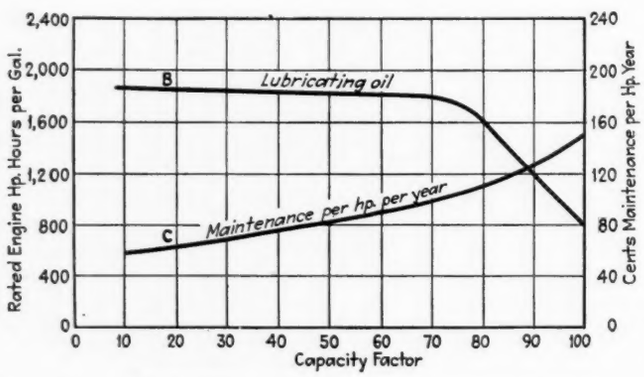


Fig. 3—Lubrication and maintenance at various capacity factors

THE MANAGEMENT and operating force of many diesel plants fail to give proper consideration to the question of load balancing between the several engines in the plant. True, the fuel consumption of a diesel is good at all outputs from about 25 per cent load to full load, but there is some point at which a particular engine has its best fuel economy, and by proper division of the plant load between the several engines the maximum fuel economy for the group may be secured.

In addition to the fuel there must be taken into consideration the lubricating oil and the maintenance costs, both of which vary to some degree with the load. On the other hand, labor and capital charges are not altered when an engine is idle or carrying full load.

For the purpose of outlining how load balancing may be predetermined I shall describe the method followed in one plant under my charge. It should be understood, however, that some other plant probably will find another load division, the economical one by reason of different fuel rates, lubricating oil consumptions and maintenance costs. But the method of approaching the subject can be applied to any plant.

The plant in question contains three 750-hp. diesel generating units, and while the generators can deliver 520 kw., 500 kw. has always been assumed as full load, which gives a small margin of overload if needed.

The fuel consumption curve is shown in Fig. 1, as is also the total fuel consumed per hour for all loads. It will be noticed that the curve covering the fuel per horsepower hour is rather flat; at one-quarter load the value is at least one-tenth pound less than is usual. This may be ascribed to the make of engine, which has this flat-curve characteristic. The result is that the *total fuel per hour* curve is practically a straight line, quite like a Willans Line. It is necessary to transform these values into fuel per kilowatt-hour, which may be accomplished either by employing the guaranteed generator efficiencies or by conducting an actual output test on each unit. Initially, in the plant in question, the guarantee values were used; a subsequent check by actual outputs revealed but slight discrepancies.

It will be noticed from Fig. 1 that as the engine load increases the fuel per horsepower-hour falls off, so that the first assumption is naturally that it is always advisable to fully load one engine. But the converse may be true; for example, a 1,125-hp. load might be divided by one unit carrying a 750 hp. and a second engine carrying 375 hp., with a fuel consumption of 500 lb. If the load be evenly divided between two units, each with 562 hp., the fuel will total 494 lb. However, the lower generator efficiency at low loads must not be ignored. Consequently it is well to change horsepower-hours to kilowatt-hours,

plotting the latter against the former as in Fig. 2.

For example, a 750-kw. load might be carried on two engines, loaded at 500 and 250 kw. each, with total fuel of 67.5 gal. By placing 375 kw. on each of the two units the fuel consumption will be 67 gallons.

Fuel is not the only item to be considered. Lubricating oil is of consequence and on low loads may be equal to one-fifth the cost of the fuel.

The reason for this is that the amount of lubricating oil consumed does not depend so much upon the engine output as upon the size of the engine and the hours operated. An engine operating at quarter load consumes practically as much oil as at three-quarter load. Most of this oil is that introduced upon the cylinder walls, which must be covered with an oil film of a constant thickness regardless of the load. After three-quarter load the amount of lubricating oil may increase, since the higher cylinder temperature causes an increase burning of the oil film. The engines in question show the lubricating oil rates indicated in Fig. 3; the fuel load rate is twice that at loads below 70 per cent. The lubricating oil consumption expressed in terms of cost is shown in Fig. 4.

On the other hand, the wear and tear on an engine depends both upon the length of time run and upon the load carried. This item various widely in different plants, in some ranging as high as $5 a hp.-year; the costs of the plant in question over a four-year period are covered by curve *C* in Fig. 3. It must be pointed out that these are based on the records of a plant which was constantly expanding, and it is possible that the increased costs that occurred at the higher load factors may be due to some extent to the aging of the engines.

Values from Fig. 3 have been transferred to Fig. 4 and expressed in terms of the hourly cost at various kilowatt loads. The three items: fuel, lubrication and maintenance have been totaled to give the total-cost curve *D* in Fig. 4. Attention is called to the change in the slope of the curve at 360 kw., due principally to the lubrication item.

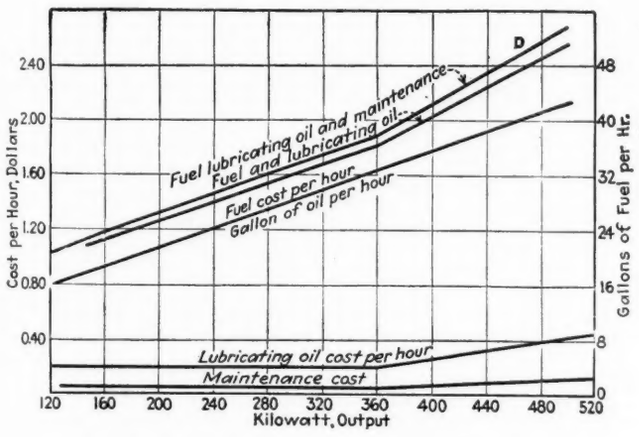


Fig. 4—Total variable operating costs per hour

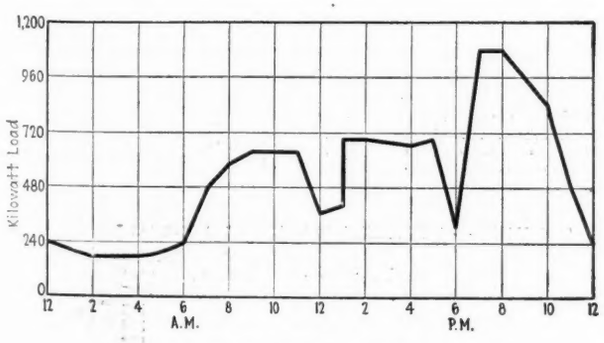


Fig. 5—Typical load curve of a plant

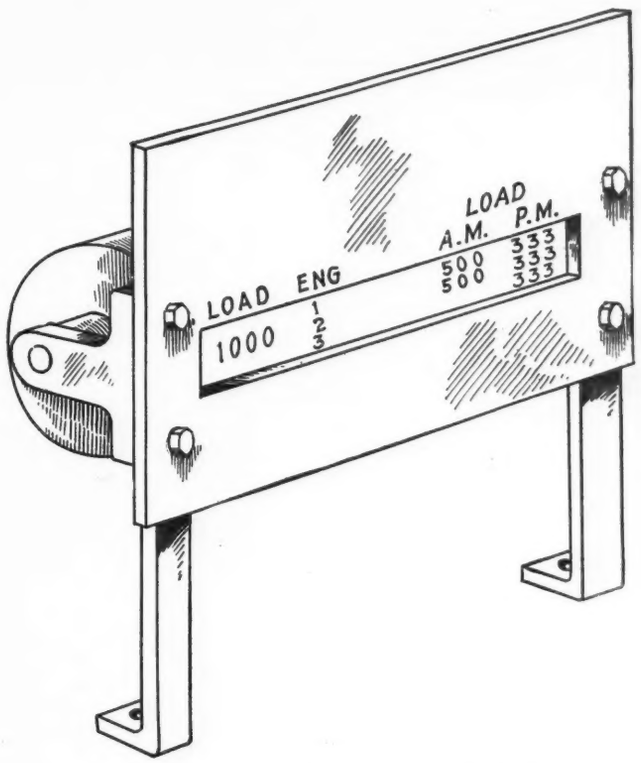


Fig. 6—Indicator employed to balance load

With this total hourly cost curve available it is but a matter of computation to discover how any plant load should be distributed. Let it be assumed that the three 500-kw. units are confronted with a 900-kw. load. The problem is to distribute the load economically. To do this the following tabulation was made.

Group	Engine No.	Load Kw.	Hourly Cost	Total Group Cost
I	1	500	$2.70	
	2	200	1.32	
	3	200	1.32	$5.34
II	1	500	2.70	
	2	250	1.50	
	3	150	1.13	5.33
III	1	400	2.12	
	2	300	1.67	
	3	200	1.32	5.11
IV	1	300	1.67	
	2	300	1.67	
	3	300	1.67	5.01
V	1	500	2.70	
	2	400	2.12	4.82
VI	1	450	2.40	
	2	450	2.40	4.80

It will be observed that the lowest cost is by Group VI, where two engines evenly divide the load. This condition will exist in most plants where the units are identical, that is, the cost is cheapest when the load is evenly divided between the fewest possible number of engines.

Not only should the existing plant load be considered in balancing, but the expected load in the immediate fiuture must be given cognizance. Taking the load curve of Fig. 5 for illustration it will be agreed that although the load at 6 p.m. could be handled by one engine, to provide for the rapid rise in the demand which occurs in this example between 6:30 and 7 p.m. a second engine should be warming up. Possibly the engineer might not actually

close the main switch, since a 240-kw. load divided between two engines would be so small that the governors might operate irregularly.

Judgment must be employed in determining how much margin of engine capacity should be on the line. At times economy may be sacrificed in favor of reliability. A load of 1,000 kw. could be carried by two of the 500-kw. units with a total hourly cost of $5.40, but this would leave no reserve capacity available in case of a sudden rise in the load. Consequently it is advisable to operate three engines, each carrying 333 kw., for which the cost happens to be the same as for two engines carrying 500 kw. each.

To permit the shift engineer to operate the engines properly balanced, an aluminum wheel or drum was mounted upon a metal board below the pyrometer dial, as shown in Fig. 6. On this drum was glued a paper upon which loads at increments of 100 kw. were printed, together with the number of engines to be run and their loads. Two sets of figures are given, one for day and the other for evening periods, properly labelled.

▼

Types of Gates Used on Dams in Europe

By ERIC C. MOLKE
Montreal, Canada

OUT OF the many gate types that have been developed, a few rigid and simple constructions that can be applied in severe climates will be mentioned to show the most important types used in Europe. Sluice gates are now built with fixed rollers only. Two vertical sections are mostly provided, to permit passing ice and floating trash without loss of much water and also to prevent washing out of the dam's foundation. The upper gate section can be lowered when the lower section is lifted. The water falling over the gate and that from underneath meet downstream, destroy their energy and reduce the scouring at the toe of the dam. Fig. 1 shows the older type, a conservative design still used on some new plants, like Albruck Dogern on the Rhine and Kembs, France. The disadvantage of this type of gate is that separate guides are required for each section, which necessitates a longer span for the upper section.

Fig. 2 is a cantilever-type double sluice gate, a widely used construction, which permits lowering the upper gate to about a third of the total height, both gates moving on the same guides. In each section only two main girders are provided, whose ends are directly carried by fixed roller trains, so that bearing conditions are as simple as possible. Special care is taken in designing the crest, as heavy vibration was experienced with the first constructions.

The third type of double sluice gate, Fig. 3, the guillotine, is being used on some of the newest constructions, like Ryburg Schworstadt on the Rhine and Klingnau on the Aare, Switzerland, where sudden rises in the river flow have to be handled. The upper section has only one stiff girder, and that is on top. The lower end of the upper gate is supported by rollers on the lower section. Almost half the gate opening can be obtained by telescoping the two sections.

Sluice gates with flaps on top that can be turned on a horizontal axis have also been built lately, Fig. 4. Difficulties were experienced on some of these gates. The gate deflection would slightly bend the horizontal axis of the flap and prevent movement of the latter.

Ice troubles with double gates were experienced in the cold winter of 1928 and 1929 at the Kachlet plant on the Danube. The ice prevented movement of gates on each other, no heating arrangements being provided at that date. To illustrate the development of gate sizes on some recent plants on the river Rhine, Table I was compiled.

Segment weirs are not widely used but were built on a few recent developments. One of these is (Fig. 5) on the dam of the Neckar canal near Heidelberg with a movable ice flap on top. The flap is connected with the lifting mechanism in such a way that it must be lowered before the main section can be elevated. Some ice troubles have developed on this design, lumps of ice wedging in between the flap and the dead points while lifting, no heating arrangements being provided.

Sector gates operated hydraulically were also installed on some developments, a sector of steel or reinforced concrete being used and pushed up by head-water pressure from a pit in the foundation. They are not favored at the present time, although their operation is simple. Ice and silting trouble are given as the objection to their use.

The bear-trap gate, an old American invention, is used in a modified form on quite a number of medium-sized plants. Such gates, however, have not been built in the last five years. Two flaps hinged upstream and downstream, respectively, are kept up in the shape of a roof by head-water pressure. The structure is raised or lowered automatically according to the head-water level. Difficult problems in the foundation, ice and silting troubles were experienced.

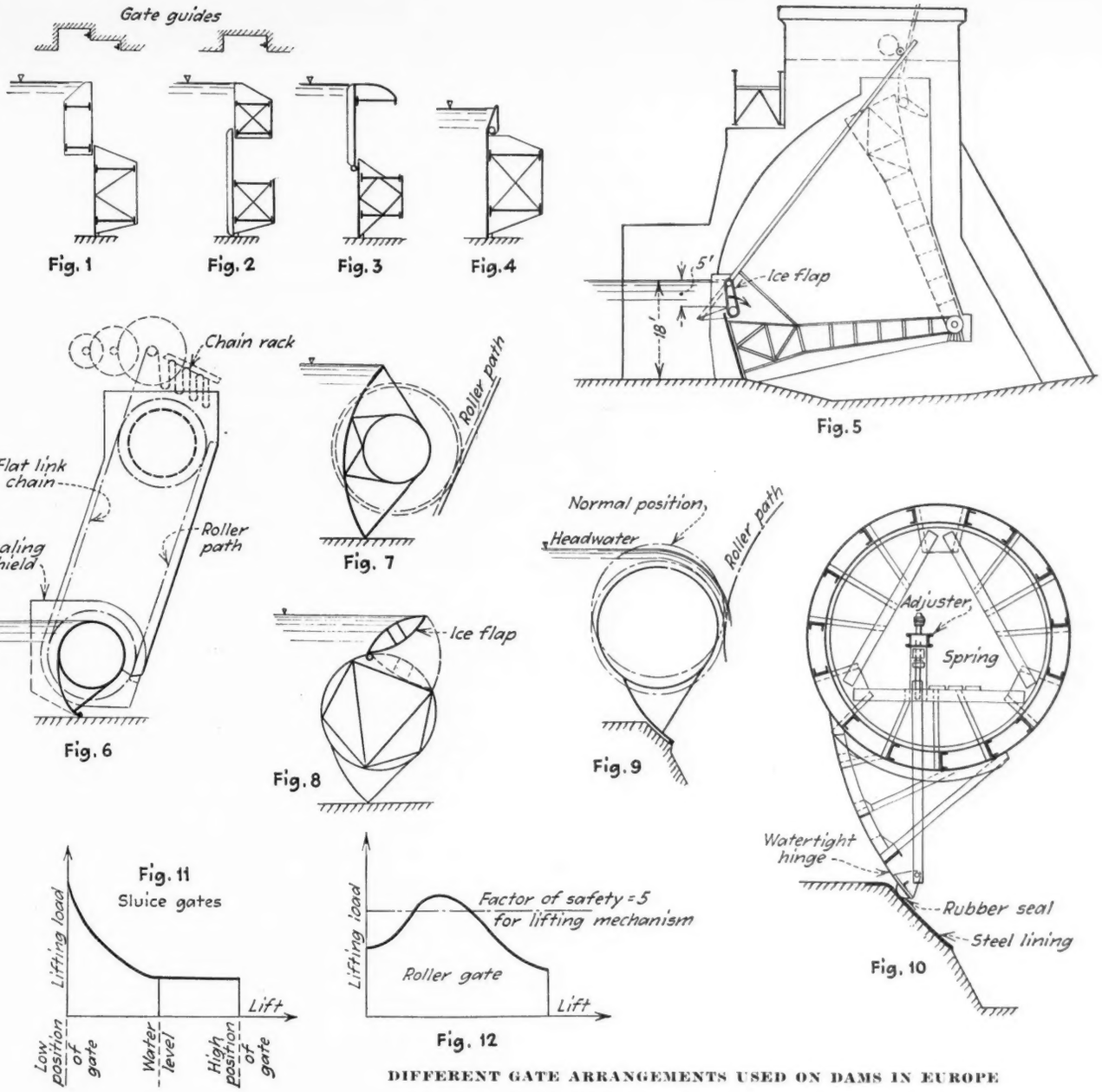
Roller gates are now the most widely used type for power and river work. They are steel-plate cylinders, rolling up and down on inclined or vertical guides. Hollow cylinders being the most economical form of girders for loads in any direction, these gates form a sturdy and simple closing member. The steel cylinder is stiffened by structural steel and is always open for inspection. By means of cast-iron segments bolte[illegible]o the rollers they rest at both ends on steel racks, me[illegible]ıg to them. The cylindrical form of the roller gate[illegible]ers ample resistance against torsion. Most roller gat[illegible]ave a beak-like projection at the sill, Fig. 6, which [illegible]rries the sill seal, an oak or rubber strip wedged into a steel groove. For the higher gate depths the steel cylinders become merely a structural part, the skin plate being formed by a shield set in front of the cylinders as in Fig. 7.

TABLE I — EXAMPLES OF DOUBLE SLUICE GATES ON THE RHINE

Name of Plant	Year Completed	Gate Opening, Height, Feet	Gate Opening, Length, Feet	Type	No. of Openings	Pier Width, Feet
Eglisau	1920	38.5	51	Fig. 1	6	14.1
Ryburg Schworstadt	1930	39.5	79	Fig. 3	4	16.4
Kembs	1932	38	99	Fig. 1	5	16.4

TABLE II — TYPICAL ROLLER GATE INSTALLATIONS

Name of Plant	Year Completed	Gate Opening, Height, Feet	Gate Opening, Length, Feet	Type
Ladenburg, Neckar	1925	15	148	Fig. 6
Raanaasfoss, Glommen	1919	21	148	Fig. 7
Freudenberg, Main	1932	21	109	Fig. 8
Ybbs, Danube	Projected	39	158	Fig. 10



DIFFERENT GATE ARRANGEMENTS USED ON DAMS IN EUROPE

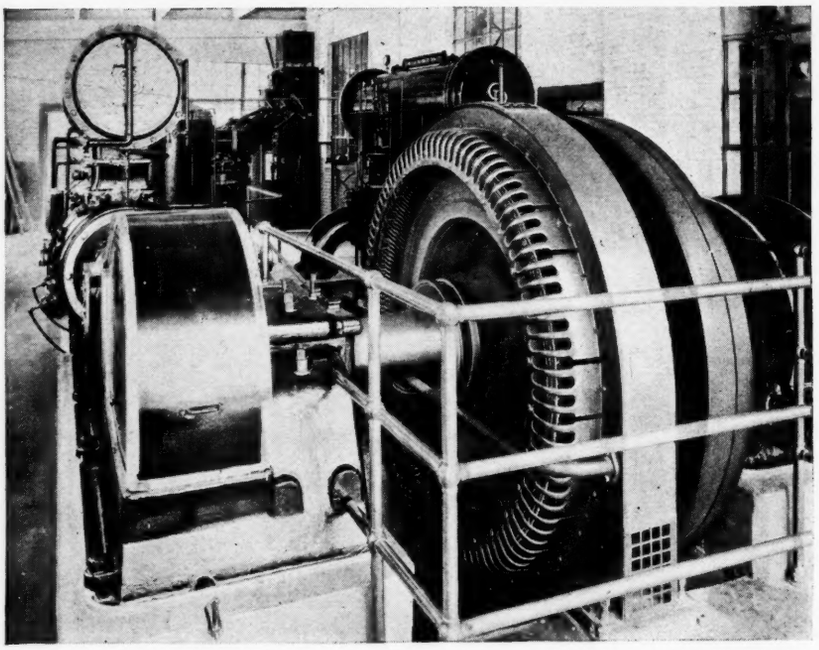
Sealing of roller gates at the ends is accomplished by small steel shields projecting out from each end of the roller. On the edges of these shields oak strips are pressed into contact with the steel-lined face of the piers by water pressure on the shields. Contraction and expansion of the gate due to temperature changes is also taken care of by the flexibility of these shields. In very cold districts the shields are electrically heated and no trouble has occurred on roller dams due to ice.

There are a number of roller gates built with ice flaps on the top, operated by the movement of the link chain, Fig. 8. They appear to operate very well but cannot be recommended for rough use in severe climates.

Many roller gates are built submersible so that they can be lowered below their normal position to allow passage of ice, Fig. 9. The roller path is curved in such a way that the beak-like projection on the cylinder can slide along the steel-lined crest of the substructure. The seal on the end of the beak is adjustable by a simple screw and spring arrangement inside the cylinder, as shown in Fig. 10.

Roller gates are used on about 160 different dams, in heights up to 42 ft. and lengths up to 148 ft. They save a considerable amount of concrete in piers by reducing the number of gate openings necessary. A roller gate, particularly on shorter spans, contains slightly more steel than ordinary gates. On long dams the total costs of such structures with roller gates are the same or less than with ordinary sluice gates under European conditions. The cost of upkeep is claimed to be lower for roller gates, due to the simple and heavy construction parts; also, their operation is simpler.

A comparison of Figs. 11 and 12 shows the advantages of the roller dam over ordinary gates. While the maximum load on the lifting motors occurs when the ordinary sluice gate is in the bottom position, where incalculable resistance due to ice is at its highest, the maximum for roller dams is at some mid-position. On account of the maximum of uplift on the roller when in lowest position the initial force necessary to raise a roller gate can be kept much lower than the maximum force that occurs after the roller is in a raised position.



A 700-hp., 200-r.p.m., 2,300-volt 3 unity-power-factor synchronous motor driving a reciprocating air compressor

Torques Required by Synchronous Motors

By M. N. HALBERG

Industrial Engineering Dept.
General Electric Company

Synchronous motors have peculiar torque characteristics that must be taken into account when selecting them for a given application, and a motor chosen that has a proper relation between starting, accelerating and pull-in torques to suit the driven machine

BEFORE selecting any type of motor drive it is essential that a comparison be made of the torque delivered by the motor and the torque required by the load throughout the starting cycle. Synchronous motors have certain unusual torque characteristics that must be understood in order to compare them with those of the load.

It is well known that during the accelerating period a synchronous motor operates as an induction motor, the amortisseur winding in the pole tips acting as the squirrel-cage winding of an induction motor. Like the induction motor, the torque delivered at any point depends only on the motor speed and on the applied voltage. The curve represents the speed-torque characteristics of either a typical general-purpose, squirrel-cage induction motor or a typical general-purpose synchronous motor. However, after direct-current excitation is applied to the synchronous-motor field and it pulls into step, that is, operates at synchronous speed, it loses its induction-motor characteristics and operates as a synchronous motor. It will then deliver whatever torque is required by the load, without any change in speed, within the limits of its maximum synchronous torque. The maximum synchronous torque depends on the terminal voltage and on the amount of direct-current excitation applied.

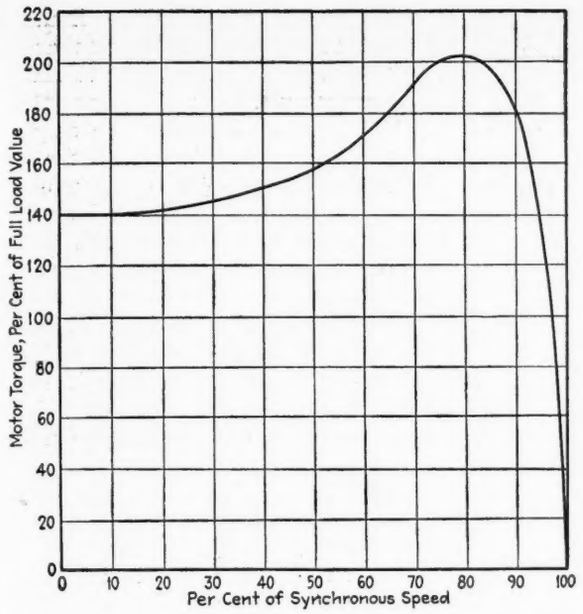
The starting torque of a synchronous motor is defined as the torque delivered at zero speed, that is, the torque available for starting the load. Since this is an induction motor torque, its magnitude varies as the square of the voltage at the motor terminals. Thus with 80 per cent voltage applied the starting torque will be 64 per cent of that obtained with 100 per cent full voltage.

The pull-in torque of a synchronous motor, as ordinarily defined, is the induction motor torque delivered at 95 per cent of synchronous speed. However, the pull-in torque does not indicate directly the maximum load torque which the motor can synchronize. It simply defines the induction-motor torque curve near synchronous speed and thus determines how close to synchronism a given load can be brought. This, in turn, determines whether the motor can synchronize when field is applied. The minimum speed or maximum slip from which a given motor can synchronize is not constant but depends on the flywheel effect (WR^2) of the load. The following expression gives the maximum slip S from which a motor will always synchronize when field is applied.[1]

$$S = \frac{590}{RPM}\sqrt{\frac{P_m}{WR^2 \times F}}$$

Where S = Maximum slip from which the motor will always synchronize.
RPM = Synchronous speed of motor.
P_m = Kilowatts of maximum synchronous output produced by the excitation current applied. (If rated excitation is applied to synchronize, P_m is approximately equal to the pull-out torque expressed in kilowatts.

[1]See "Pulling Into Step of a Salient-Pole Synchronous Motor," by H. E. Edgerton and Paul Fourmarier, presented at the mid-winter convention (1931) of the A.I.E.E.



Speed torque curve of a general-purpose synchronous motor

WR^2 = Total flywheel effect (motor and load) in lb. (ft.)^2
F = Line frequency.

If the load is not directly connected to the motor, but is connected through gears, chain, or belt, so that it runs at a different speed than the motor, its WR^2 should be referred to the motor shaft by multiplying by the ratio:

$$\left(\frac{Speed\ of\ load}{Speed\ of\ motor}\right)^2$$

As an example of the use of the above formula, consider a case where a 300-hp., 900-r.p.m., 60-cycle synchronous motor is to be applied to a load having a WR^2 of 1,500 lb. (ft.)^2, and requiring 100 per cent torque during pull-in. Assume that the motor has a speed-torque curve as shown above and a rotor WR^2 of 650 and has a maximum synchronous torque with rated excitation applied of 175 per cent of full-load torque.

Then $P_m = 1.75 \times 0.746 \times 300 = 392.$
$WR^2 = 1{,}500 + 650 = 2{,}150.$
$f = 60.$

$$S = \frac{590}{900} \times \sqrt{\frac{392}{2{,}150 \times 60}} = 0.0361.$$

This indicates that the motor must be capable of bringing the load to a slip of 3.6 per cent, or to 96.4 per cent of synchronous speed, in order that it may pull into step. An inspection of the motor torque curve indicates that a load of 100 per cent can be brought to 97 per cent speed so that the assumed load can be synchronized. However, if the pull-in torque of the motor (induction motor torque at 95 per cent speed) had been only 100 per cent, the motor would not have been able to synchronize this load, since it had to be brought above 95 per cent speed in order that it could be pulled into step.

Like the starting torque, the pull-in torque of a synchronous motor varies as the square of the voltage at the motor terminals. The pull-out or maximum synchronous torque varies almost directly with the line voltage. Hence the amount of load which the motor can pull into step varies rapidly with changes in line voltage. If the voltage at the time of synchronizing is 10 per cent below normal, the maximum load of a given WR^2 which can be synchronized is only 77 per cent of the value which could be synchronized if the voltage were normal.

Synchronous motors driving tube mills in a cement plant offer an example of a load that has relatively little flywheel effect, when referred to the motor shaft, so that it can usually be synchronized from 95 per cent speed. Since the load torque near synchronous speed is 100 per cent, a pull-in torque of 100 per cent is required. A synchronous motor for driving a reciprocating air compressor often has considerable flywheel effect incorporated in its rotor, or a separate flywheel is used. Although the air is bypassed during the starting period, so that the compressor torque seldom exceeds 20 per cent, a pull-in torque at 95 per cent synchronous speed, of 30 to 40 per cent is usually required.

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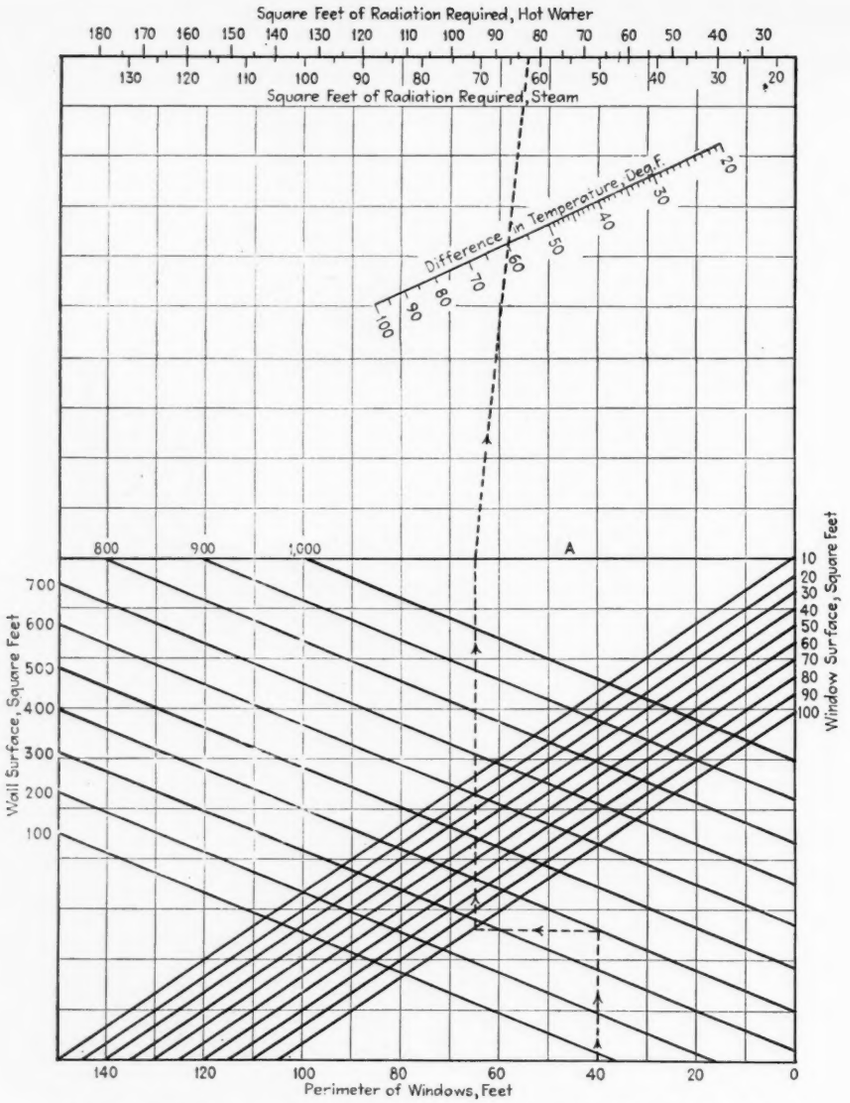
Chart for Computing HEATING SYSTEM RADIATION

By HENRY C. OATLEY

THE amount of radiation to be provided in plant additions or for new buildings is determined by computing the heat loss from the building, assuming an inside and an outside temperature. The inside temperature is fixed arbitrarily at the desired figure. The outside temperature is obtained by consulting the weather bureau records over a period of years for the section of the country where the building is to be erected. The figure used is usually taken as ten to fifteen degrees above the average minimum temperature over a period of ten years.

There are a number of formulas in use for computing heat loss from buildings, each of which has certain advantages. One commonly used is that of Harding & Willard, which is:

$H = (1.2P + \frac{1}{4}W + G)\ (t - t_o)$, where
H = heat loss
P = perimeter of windows
W = wall surface
G = glass surface
t = room temperature
t_o = outside temperature


Square Feet of Radiation Required, Hot Water
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30
130 120 110 100 90 80 70 60 50 40 30 20
Square Feet of Radiation Required, Steam
Difference in Temperature, Deg. F.
20 30 40 50 60 70 80 90 100
800 900 1,000 A
Wall Surface, Square Feet
700 600 500 400 300 200 100
Window Surface, Square Feet
10 20 30 40 50 60 70 80 90 100
140 120 100 80 60 40 20 0
Perimeter of Windows, Feet

From this chart the amount of steam or hot water radiation required to heat a building can be determined

The accompanying chart is based on this formula and will prove a time saver where much of this work has to be done. The factor used with the wall surface agrees closely with data in the A.S.H.V.E. Hand Book for brick and tile walls 18 in. thick. Where insulation or construction material of high heat transfer is used allowance should be made for decreased or increased heat loss.

In using the chart enter it with the perimeter P, rise vertically from this point until the line corresponding to the given wall surface is intersected. Then move horizontally to intersect the line of window surface. From this point rise vertically to line A. Using a straight edge, line this point up with the temperature difference. The square feet of radiation required may be read directly on the horizontal scale at the top of the diagram. It will be observed that one side of this scale gives the square feet required if steam is used, while the other side gives the square feet necessary if hot water is the heating medium.

Construction of the chart is simple; the method is outlined below. After the limits that are to be worked between are determined the next step is to simplify the formula.

The chart is really two diagrams, the lower half being of the form $A = 1.2P + \frac{1}{4}W + G$ while the upper half is $A \times (t - t_o) = H$. In constructing the lower half, first lay out the scale for the perimeter on the bottom line. The form $A = 1.2P + \frac{1}{4}W + G$ is again simplified by letting $B = 1.2P + \frac{1}{4}W$ and $A = B + G$. The first step is to plot $B = 1.2P + \frac{1}{4}W$. B is laid off along one of the vertical lines and a series of points plotted for a given value of W.

For instance, for the line $W = 100$, assume $P = 20$. Then $B = 24 + 25 = 49$. Since the lines will be parallel, after the first line is constructed it is necessary to plot only one point for each of the other lines.

The next step is to plot $B + G = A$. This is done in the same manner, except that the scale for A is laid off along the horizontal scale marked A in the diagram.

This completes the first half of the diagram. The next step is to construct a diagram for the equation: $A \times (t - t_o) = H$.

Along the horizontal line at the top of the diagram a scale of B.t.u. must be laid off. The next step is the construction of the slant scale for the difference in temperature. Connect the point on $A = 100$ and the point on the B.t.u. scale $H = 6{,}000$. At some point on this line will be the point $(t - t_o) = 60$, since $60 \times 100 = 6{,}000$. To determine the location on the line select another pair that will give 60 for a quotient, for instance, $A = 90$ and $H = 5{,}400$. In like manner other points may be plotted and the slant scale drawn through them. With the construction of this scale the chart is completed except for the elimination of non-essentials.

Since the scales A and B are not necessary to the solution and would only make the chart more confusing, they may be eliminated from the final diagram. Also since it is square feet of radiation that we are interested in and not B.t.u. the top scale may be replaced with one which reads in square feet instead. In constructing this scale consider that 240 B.t.u. equals one square foot of steam radiation and 180 B.t.u. equals one square foot radiation for hot water.

An interesting feature of this chart is that it combines two forms. The lower half is a cartesian coordinate diagram while the top half is a form of alignment diagram. The chart could have been made entirely in either form but it was felt that combination was best because it required least space and was least confusing.

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PRACTICAL AIDS TO OPERATION

Mercury Switches Used on High and Low Water Alarm

In An automatic pumping plant controlled by a Selsyns it was desirable to install a signal and alarm system. The signal system was intended to operate and notify the operator that something was wrong if the Selsyns failed. It was also desired to provide the operator with the necessary information to run the plant until the Selsyns could be repaired. Three water levels, high, low and intermediate, were to be indicated. This was accomplished by using three mercury switches, two 25-watt lamps, two relays and a horn. If only a visual indication is desired, then the relays and horn may be omitted. The circuits were wired for 110-volt operation and the relay connected so that as long as they were alive their contacts would be held open.

The diagram shows the circuits for the different parts of the system. No. 2 mercury switch is normally open and operates the high-water alarm. No. 3 mercury switch is normally open and is on the low-water alarm. No. 1 mercury switch is normally closed and in series with No. 3 switch to form an interlock between the high- and low-water alarms, so that both circuits cannot be closed at the same time and cause a short circuit. With the mercury switches in their normal positions, as in the diagram, a circuit is completed from the + side of the line through the two lamps in series and the two relay coils in series to minus side of the line. Under this condition the lamp shows a low brilliancy and indicates the intermediate water level. The relay contacts are held open so that the alarm horn cannot sound.

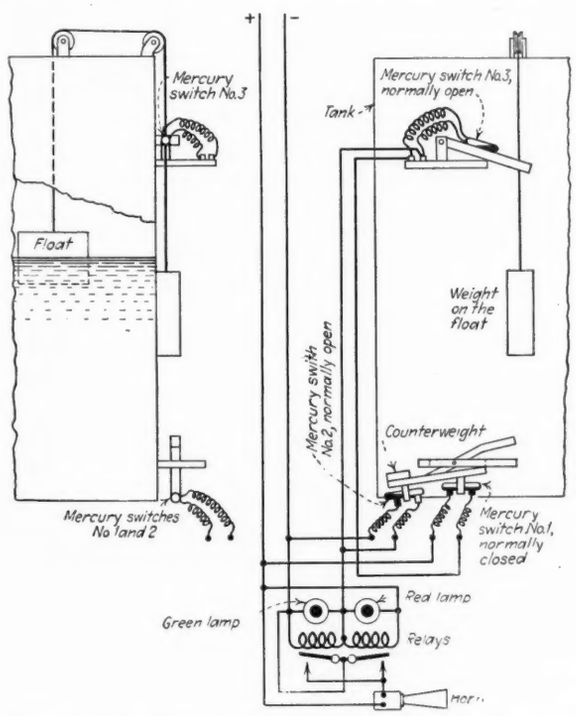


Diagram of circuits for high- and low-water alarm system

When the tank fills, the weight on the float comes down on the lever supporting mercury switches Nos. 1 and 2 and opens No. 1 switch and closes No. 2. When No. 2 switch closes it short circuits the green lamp and the relay coil connected to its terminals. This causes the green lamp to go dead and the relay contact to close and complete the circuit through the horn to give high-water alarm. On low water the weight comes up and closes mercury switch No. 3. Closing of this switch completes a circuit through it and mercury switch No. 1 to short circuit the red light and its relay. The alarm circuit is again closed and calls attention to high water when the pumps may be shut down. C. A. Miller.

Crockett, Calif.

Corrosion Prevention Methods In Brine Tanks and Ice Making Tanks

It has been some time since the original recommendations of the Corrosion Committee of the American Society of Refrigerating Engineers were published, and it is of interest to note that these recommendations have worked out well in practice. However, a number of precautions have not always been observed, with the result that the brine treatment did not give the desired protection.

For example, it has been found that best results are obtained, if, in making up a tank full of brine, the water with the treatment in it is reduced in temperature below 40 deg F. before introducing the calcium chloride or sodium chloride for making the brine. This is very important, as warm brine is corrosive. In fact, practice has disclosed that if this precaution of cooling the water before making the brine is not followed, the galvanizing on the ice cans may be severely attacked before the plant has started to make ice.

The approved procedure is to place the cans in the tank, fill the cans with water, and then run water into the tank, allowing sufficient leeway for the addition of the calcium or salt. One hundred to 125 lb. of commercial sodium dichromate should be dissolved in the water in the tank for every 1,000 cu.ft. of brine in the tank. Slightly greater amounts of sodium dichromate up to 200 lb. per 1,000 cu.ft. of brine should be used, if the brine is made with sodium chloride.

Many people are of the opinion that a chemist should be employed to test the brine to see whether it is acid or alkaline. For that reason they neglect to obtain the protection, which they could obtain for a few dollars, when a new plant is started up. It will be found, however, that excellent protection can be obtained in starting up a new plant by merely introducing the sodium dichromate into the water, then making the brine in the usual way.

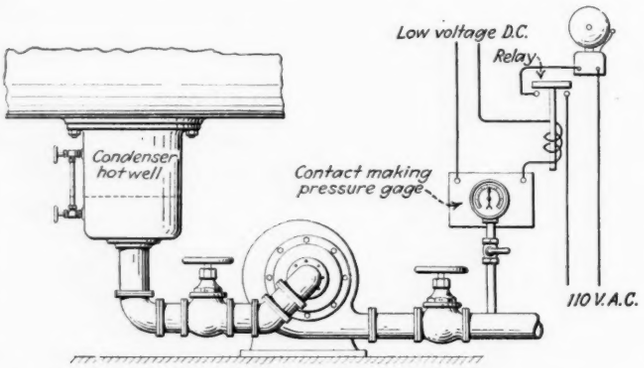
It has also been found best to throw away old brines that have been subjected to ammonia leaks, if new cans are to be placed in the tank. Brines contaminated with ammonia and treated with muriatic acid to reduce alkalinity are usually very corrosive. Likewise in old installations where cans are leaky and coils are thin due to rust, the treatment of the brine with sodium

dichromate will clean off the rust to such an extent that leaks and consequent trouble may result. Extreme care and judgment must be observed in these cases.

Milwaukee, Wis. R. S. WHEATON.

Condenser Hotwell Alarm System

THERE ARE numerous alarm devices in use to give warning of hotwell pump failure in condenser service. Nearly all of these are based on some type of float switch and operate when the water level rises into the condenser beyond some predetermined safe point. In many cases,



Contact-making pressure gage on pump discharge gives instant warning of pump failure

however, if the warning is not given until the water rises into the condenser it will usually be too late to prevent a shutdown and possible damage.

By the use of a standard pressure-contacting gage on the hotwell pump discharge, as shown, the alarm will be given as soon as trouble occurs at the pump, thereby allowing a longer time in which to correct the trouble. In the installation shown the contacts on the gage are set to connect at 2 lb. pressure. H. M. SPRING.

Boston, Mass.

Uses Thermal Overload Relays to Protect Three-Phase Motors

WHEREVER possible, it is our practice to eliminate fuses in the protection of three-phase motors. Other devices that are relatively low in cost are now available for protecting motor circuits. Where fuses are necessary in the circuit it is our practice to use fuses of such a rating that no condition of motor load will cause them to function, even though the motor may be stalled with full voltage applied. This means using fuses about seven times the full-load current rating of the motor. These will blow only in case of a short circuit on the line, which is the primary reason for using a fuse in our case.

Fuses cannot be depended upon to protect alternating-current motors against overload. If each individual motor, however, is equipped with thermal-overload relays, these, if properly selected and adjusted, will protect the motor against overheating, whether this overheating is caused by an actual overload or by single-phase operation.

Many engineers attempt to test fuses with a three-phase motor in operation. Upon finding approximately full voltage across the different lines and motor ends of the fuses they assume that the fuses are complete. This however, is not necessarily true. If a voltmeter is used that will read low enough to measure the voltage drop due to resistance through the motor windings, such a meter may be used to measure the voltage drop between the terminals at each individual fuse not across the line. If the fuse is not blown, there will be no measurable drop, but if it is open and the motor is in operation, a small voltage will be measured across the open fuse which is equivalent to the voltage drop across the motor's winding. EARL E. NORMAN, *Director*

Kalamazoo, Mich. *Dept. of Public Utilities*

Fuses and Thermal Cutouts Protect Three-Phase Motors

THERE are many solutions to the problem of preventing single-phase operation of three-phase motors. The least expensive remedy is thermal cutouts. Each motor should have a separate set of thermal cutouts and the main switch should be fused at the capacity of the feeder. The thermal cutouts will open when there is trouble or overload on the motor it is protecting. The main fuses are back-up protection, to take care of short circuits on the feeder. Thermal cutouts may be obtained to protect motors of any rating.

If a motor installation warrants better protection than the thermal cutouts and fuses will provide, a phase-balance current relay may be installed and will protect against running, in case of polyphase unbalances that cause undue heating; against running with one phase open; against running with a phase reversal; and against operating under dangerous overload or short-circuit conditions. G. E. PICKETT.

Raleigh, N. C.

CURRENT COMMENT

Comparative Costs of Capacitors and Synchronous Condensers

I WAS much interested in reading the answers to O.R.'s question on power-factor correction in your March 1, 1932, number, especially Mr. MacCorkle's reply; however, I should like to make some corrections in his figures. In the first place, the cost of capacitors varies widely according to the voltage and there is also quite a divergence in cost of various sizes per kilovolt-ampere for a given voltage. The following figures will hold approximately for sizes from 3,000 to 150 kva., exclusive of installation charges, which are small for this

type of apparatus: 220 volts, $23.50 to $27; 440 volts, $14 to $17; 2,300 volts, $9.50 to $13. For sizes below 150 kva. the cost goes up rapidly, at 30 kva. it being approximately for 220 volts, $38; 440 volts, $28; and for 2,300 volts, $26.

Capacitors for 550 volts are slightly lower in cost than 440-volt units. Those for 4,000 volts are the same price as the 2,300-volt designs; and 4,600- or 6,000-volt capacitors cost approximately the same as the 440-volt designs, being slightly cheaper in the larger sizes and slightly higher in the small sizes.

It is also impossible to say that above a certain rating synchronous condensers should be used, while below this rating capacitors should be used. I do not believe that Mr. MacCorkle meant to leave the impression that 1,000-kva. capacity was a definite dividing line between these two classes of equipment, but it is possible that some might infer this. This again depends upon operating conditions and rate schedules.

For instance, in some cases it might be desirable to have automatic control of the power factor with a comparatively small equipment. This could be obtained more easily by means of field control on a synchronous condenser than it could be by sectionalizing a bank of capacitors. If power-factor correction is required 24 hr. a day, the cost and savings will be more in favor of the capacitor as compared to the synchronous condenser than as if the correction is required only 8 or 10 hr. a day. This is on account of the high relative losses in the synchronous condenser and, other conditions being the same, will usually change entirely the rating at which the synchronous condenser becomes the most economical.

Cleveland, Ohio. T. E. Ormiston,
Engineering Department,
General Electric Company.

Sketches and Notes Versus Trouble and Waste

In discussing the scarcity of answers to question discussed by readers in the May 17 number of *Power* on a system of filing tracings and blueprints, the editor expresses some surprise that more answers were not received and attributes the cause to the fact that engineers are usually engrossed in problems of boilers, engines and so forth and do not care to go out of their line.

In many large plants the blueprints and sketches are filed away in a system similar to the one suggested by George P. Pearce. These drawings are subject to removal from files only on a foreman's order, an order similar to one used in drawing stock from warehouse. The foreman gets his order back when he returns the blueprint, in that way a check on the prints is always available. These files are usually located in a fireproof vault. The custodian of the files acts as caretaker of this vault, as he is responsible for the contents.

On the other hand in small plants, where all the maintenance work is done by the engineer or a small repair gang, it has been my experience that the engineer does not make sketches. This, perhaps may explain the scarcity of answers submitted to the question.

Many an engineer insists upon keeping the plant under his care so that it presents a pleasing appearance. This same engineer cannot or will not make sketches or notes. If he does do anything along this line, the sketches are usually not intelligible to anyone else—and sometimes not to himself when they are but a few weeks old. If he attempts to make records his method of filing them for future reference is not at all in keeping with the way he operates the plant.

When a repair job or an alteration is done once, it is no assurance that it will not have to be done again. Further, a change which has been made may not prove satisfactory and it may be advisable to make further changes. Without a good system of sketches and notes much work must be duplicated.

Brooklyn, N. Y. William Anderson.

Three-Phase Motors Start On Single-Phase Line

R.C.M.'s question in the April 15 number is an interesting one, since this trouble causes many burned-out windings and is difficult to determine. Theoretically, where all three fuses are of the same capacity, when one blows, the single-phase current should be such as immediately to blow another fuse. Practically, this is not always the case.

Wherever possible, modern practice seems to be doing away with fuses for polyphase motor overload protection and substituting thermal relays. Even here, with delta-wound motors there is a possibility of a burn-out when one phase is open. This is due to the line current of a delta-wound motor being equal to 1.7 times the actual winding current. The overload relay or fuse must be set for this, but on single phase the line current will flow largely in the one circuit of the motor.

As stated by R.C.M., when an induction motor is running single-phase it acts as a phase converter to feed back voltage into the dead phase. I have seen a 100-hp. fan motor started several times on single phase due to the voltage back-feed of a 200-hp. synchronous motor, no trouble showing up until the synchronous motor was shut down. This means that a test light across the load terminals of the fuses will seldom show the blown one, because the difference in voltage when the motor is running is usually too small to be noticeable on a test lamp.

There are, however, several ways to detect blown fuses. On circuits up to 440 volts, connect a voltage tester across the line and load terminals of each fuse in succession. If the fuse is blown there should be 10 per cent to 20 per cent difference in voltage between its line and load ends and this will show up in the tester or even a lamp. A voltmeter, of course, will quickly tell the story. Some companies make a practice of removing all fuses and checking them at regular intervals, at which time poor contact clips and other defects are corrected. On high-voltage motors, which are usually large in capacity, it will generally be found that a phase-balance relay is well worth its cost in protection.

Johnstown, Pa. F. Fraser Mac Williams.

Hudson Avenue Station

Attention is called to an omission and an error in the articles describing the new Hudson Avenue Station of the Brooklyn Edison Company (May 31 number). In the table of equipment, page 832, the name of The Superheater Company, as manufacturer of the Elesco intertube superheaters installed, should be inserted. On page 826, Fig. 7, the words "first stage" in the caption should read "second stage."

READERS' PROBLEMS

CONNECTION FOR CONTINUOUS BLOWDOWN—*We are considering the installation of a continuous boiler blowdown on our 8,000 sq.ft. cross-drum boilers. From what point in the boiler should the blowdown be taken with this system?* R.E.S.

Connection should be made to the boiler so that blowdown may be taken from that point in the boiler where the water has the highest concentration. This will result in a reduction in the quantity of blowdown required. The steam drum is most often selected as the point to which the continuous blowdown system is connected, but it is advisable to test your boilers at several sampling points to determine the point of maximum concentration.

Continuous blowdown may be taken from the down stream side of the regular blowdown valves and a needle valve connected at this point for regulating purposes. The regular blowdown valves should not be used for throttling continuous flow.

WATT-HOUR METER RUNS BACKWARDS—*Two single-phase watt-hour meters are connected in the line that supplies a 200-hp. synchronous motor. When starting the motor one of the meters runs backwards until the motor reaches synchronous speed and field is applied, when the two meters will run in the same direction. What causes one of the meters to reverse its direction of rotation?* A.W.R.

The effect mentioned is due to the phase relation between the current in the current coils and the voltage of the potential coils of the meters. With a unity-power-factor load the current in one meter, *A*, leads the voltage on the potential coil by 30 deg. and in the other, *B*, a 30-deg. lag exists. If the load becomes inductive, the angle of lag will increase in *B* meter and in *A* the angle of lead will decrease and may change to lag. Under this condition of load, the speed of *A* meter will increase and that of *B* decrease.

When the power factor of the load is 0.5 lagging, the current will lag the voltage by 60 deg. Meter *B* will then have a 90 deg. lag, consequently it will stop, because when the current is out of step with the voltage by 90 deg. no effective torque is produced. If the power factor of the load is less than 0.5, then the angle between the current in the current coil and the voltage of the potential coil in meter *B* becomes greater than 90 deg. and the meter reverses.

This is what happens to one of the meters on the synchronous motor. When the motor is started as an induction motor its power factor is less than 0.5 lagging and one of the meters is caused to reverse its direction of rotation. When the motor reaches synchronous speed and excitation is applied to its field coils, the power factor becomes normal and both meters again rotate in the same direction. Increasing the field strength of the motor to where its power factor is less than 0.5 leading will cause meter *A* to reverse. This might occur if the motor were operated under light load.

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Ways to Protect Pumps

Readers answering question of May 3 suggest several methods of preventing pumps running when dry

WE HAVE SEVERAL PUMPS in our plant. On three or four occasions a pump has run dry and has been damaged before the cause of the trouble was detected. In each case the trouble has been caused by an obstruction lodging in the suction pipe. It may be that some reader can tell me of a way to cause the pump's motor to stop automatically when the suction pipe becomes stopped up and the pump starts to run dry. O.F.R.

A Temperature Coil the Stopping Medium

IT WOULD BE a comparatively simple matter to install a contact-making pressure gage on the discharge side of the pump so arranged that if the pump should run dry, with consequent loss of pressure in the discharge pipe, the pressure gage would open an electric circuit, thereby allowing the motor starter to trip out and stop the motor.

A flow meter arranged with an electric contact would give similar results provided the pump does not sometimes have to run with the discharge pipe practically closed. A less positive method of protecting the pump, but one which might be adaptable under some conditions, would be to install temperature indicating coils in the pump's glands, arranged so as to trip the motor circuit in the event of an excessive temperature rise.

The contact-making pressure gage will be the simplest and cheapest arrangement, and it will be applicable in the large majority of installations.

C. E. OLIVE.

Drummondville, Que.

Operate Switch on Absolute Suction Pressure

IF THE PUMPS operate with a suction lift, then the point of lowest absolute pressure is in the suction chamber of the pump at the entrance to the impeller. When an obstruction lodges in the suction pipe, the water column is broken and replaced with air at atmospheric pressure. An inverse pressure-regulating switch can be connected to the top of the pump's suction chamber and can be set so that when the absolute pressure in the chamber rises, the pressure switch will open the power circuit to the motor.

If the pump normally operates under a positive suction head, the suction chamber of the pump is then usually, depending on the amount of friction loss, the point of highest absolute pressure in the suction line. When the suction pipe becomes clogged, this pressure is reduced. A standard pressure-regulating switch can be connected to the top of the suction chamber and its normal direction of operation reversed, so that when the pressure drops, the motor will be cut out of the circuit.

A. H. RICHARDS.

Phillipsburg, N. J.

Screen the Intake to the Suction Line

TO PREVENT a pump from running dry when the suction line has been plugged, the first solution would be to screen the intake with a wire screen having a mesh that will pass no solids larger than that which will go through the pump's impeller. If the water contains considerable foreign material it would be best to construct the screen in the form of a square enclosure thereby screening an area that will not necessitate cleaning so often.

If screening is not feasible it would be possible to install a pressure regulator in the discharge side of the unit which could be set at discharge pressure of the pump. When the pressure dropped below a predetermined point due to the suction line becoming plugged the motor circuit would be opened. These pressure regulators are handled

by several control manufacturers and are very reasonable in price and at the same time reliable. E. E. ELLIS.

Detroit, Mich.

Check Valve Used to Operate Pilot Switch

I RECOMMEND that O.F.R. install a swing check valve with an extended shaft in the discharge line of the pumps. To the shaft of the check valve a link connection can be made to a standard float or similar switch which would be electrically connected to the automatic starter or low-voltage release coil of a compensator, whichever is used.

When the pump is running and delivering water the check valve will be open, holding the pilot switch closed. Should the suction line become clogged or the pump lose its suction, the flow of water in the discharge line will stop, allowing the check to close and open the pilot switch. This action will actuate the automatic starter or compensator, stopping the pump.

ELMER N. ANDERSON.

Austin, Minn.

Install an Orifice in the Suction Lines

THE PUMPS can be controlled by installing orifice plates or venturi tubes in the suction lines, and connecting the lead pipes from each to a reverse-acting pressure switch operating a mercoid-type contact. This contact should be in the trip-coil circuit of a contactor controlling the individual unit. When flow in the suction pipe ceases the pressure switch will close the contact, excite the trip coil and shut down the pump. Another way to accomplish this is to insert in each suction line a pitot tube made of small pipe. This arrangement will depend on velocity head to actuate the pressure switch. The use of pitot tubes will depend on size of suction pipes, capacities and other factors, while orifices or venturi tubes are not entirely dependent on any of these factors.

EDWARD B. CARY.

Cleveland, Ohio.

Underload Relay Connected To Shut Down the Motor

DURING the time the pump is loaded or under full suction, the motor will take the maximum current required by the load and likewise when the pump loses its suction the current on the motor will drop to a minimum. Therefore, if an under-current relay is installed in the motor circuit to open and close the no-voltage release of the compensator, the relay can be adjusted so that low current in the motor will cause the relay to open the no-voltage-release circuit on the starting compensator and stop the motor. A bell alarm can also be arranged on the compensator to give the signal that the pump has been shut down.

Another scheme would be to install a pressure gage on the pump's discharge, equipped with auxiliary contacts that would be closed when the pump is operating under full pressure. The gage contacts should be connected in series with the no-voltage release on the starting compensator so that when the water pressure falls to a predetermined value the contacts would open the circuit to the no-voltage release coil and shut down the motor. A. P. BROADHEAD.

New York City.

A Question for Our Readers

WE HAVE a number of chain drives in our plant, some being of the so-called silent type and others of the roller type. To obtain the best service from these drives it is necessary that they be properly lined up and maintained in that condition. The best way of checking their alignment is a problem that I do not feel we have solved to the best advantage, and I would appreciate hearing from Power readers how they do this work in their plants. E.D.C.

Suitable answers from readers will be paid for if space permits their publication. Typewritten replies should preferably be double spaced.

▼

Connects Timing Relay With Pressure Switch

IF A CENTRIFUGAL pump's suction is throttled or becomes clogged, the discharge pressure of the unit will materially decrease. With this point in mind, O.F.R.'s problem is easily solved. All that is necessary to protect the pump against damage from a clogged suction line is a simple pressure switch and a timing relay with a normally closed contact, and with a continuous duty coil wound for operating on line voltage.

The pressure switch should be set to close and open at the desired pressures, and the timing relay adjusted to operate in about ten to fifteen seconds. The pressure switch contacts would be connected into the starter-coil circuit or into the no-voltage-release circuit of a reduced-voltage starter. On the timing relay the contact would also be connected into the same coil circuit, but in parallel with the pressure-switch contacts. The relay's coil would be connected across two of the lines between the starter and the motor. Then the method of operation would be as follows:

Operating the starter to place the unit in service the coil circuit of the starter would be completed through the contact on the timing relay. Pressure-switch contacts would be open as there would not be sufficient pressure in the discharge pipe to close them. As the unit comes up to speed and the pressure builds up, the pressure switch would close. Closing of this must occur before the timing relay trips so that the starter-coil circuit will be maintained. With the pump once running the timing-relay contact remains open until the pump is stopped. Then if the pressure in the discharge pipe should drop the pressure switch will open and stop the pump.

This proposed arrangement will not only trip out the unit if the pump should run dry, but it will prevent damage in case the pump does not build up its proper pressure when started. In the latter case the unit would only remain on the line for a period corresponding to the setting of the timing relay.

G. P. ROBBINS, JR.

New Orleans, La.

Recommends a No-Water Stop

I RECOMMEND a "no-water stop," the function of which is to obviate the possibility of a centrifugal pump's being operated with the suction valve closed or after the suction has failed. In the case of a motor-driven pump, the stop operates a small switch in the control circuit of the magnetic starter. Depending upon the direction of the suction line, the float may be placed above or below floor level. When the suction pipe is full of water, the float chamber also is full and the float holds the switch closed. Should the water recede in the suction, the float drops and opens the switch, therefore breaking the holding circuit of the starter and stopping the motor.

It also has been the practice in our plant to install a heavy-wire screen at the end of the suction pipe. Just above this wire screen we have on the inside of the pipe a foot valve so when the pump is stopped this valve closes and keeps the pump primed. We also have a float switch that keeps the water at a certain level, the low level being just above the wire screen.

HAROLD J. AGATE.

Buffalo, N. Y.

Uses a Horn to Give Warning

THE LEAST costly method of protection would be to equip the pump suctions with an electric-contact vacuum gage connected so as to operate a Klaxon horn to warn the operator that the pump is running without water.

J. A. TODD.

Princeton, Ill.

THE ENGINEER'S BO

Future of Capitalism

BUSINESS LOOKS AT THE UNFORESEEN. *By Wallace Brett Donham, dean of the Graduate School of Business Administration, Harvard University. Published by Whittlesey House, McGraw-Hill Book Company, 330 West 42d St., New York City; 1932. Cloth, 6x9 in.; 209 pages. Price, $2.50.*

WITH THE SAME BOLDNESS that characterized his "Business Adrift," Dean Donham outlines in this book a sound basis for economic planning and describes the safeguards which must accompany any planned program. He considers the various plans thus far offered and evaluates them. He writes on the lost customers of American business, and offers some striking suggestions for recovering them. He probes deeply into the farm problem, the causes of the tremendous number of bank failures and the money panic. He takes up also the conflict between extreme individualism which characterizes capitalistic society and the restrictions which are inevitable in a social order organized for security, concluding that:

"A few years hence we may well look back on this period as one when we solved the problem of keeping men employed in a machine age, or as the period when, because of our failure to solve this problem, capitalism entered into a decline, capitalism with all that it might connote in social stability worked out through individual liberty, initiative and opportunity. For capitalism is on trial, and on the issue of this trial may depend the whole future of western civilization. The justification of capitalism is efficiency, not the efficiency of separate companies as producing and distributing units, but broad social efficiency. Our present situation both here and in all the great industrial nations of the world is a major breakdown of capitalism. Can this be overcome? I believe so, but not without leadership both in business and in government, a leadership which thinks in terms of broad social problems instead of in terms of particular companies."

All who read "Business Adrift" will want to study this book. It contains a wealth of helpful counsel for those who still value clear thinking.

Technical Study of Smoke

SMOKE: A STUDY OF AERIAL DISPERSE SYSTEMS. *By R. Whytlaw-Gray and H. S. Patterson. Published by Edward Arnold & Company, London, England; 1932. Cloth, 6x9 in.; illustrated. Price, $4.50.*

WHILE SMOKE was recognized as an atmospheric pollutant as far back as 1661, when John Evelyn called attention to the "dismall cloud of sea-coale by which London was smelled even before it was seen," little real scientific study has been made of it until the past decade. The public attitude with respect to smoke is probably more militant in England than in any other country. It is logical, therefore, that the best evidence of scientific investigation of smoke as a laboratory activity should center there.

"Smoke" is a work strictly for those who are, or expect to be, technically interested. Credit is given to the smoke studies made by Tolman and others in America in 1919. In general it discusses errors in the counting of smoke particles, the theory of coagulation, the formation of smoke and the structure of its particles, their size and density.

A chapter is devoted to the scattering of light by smoke and another to the movement of minute particles of different substances in various cases, under the influence of an intense beam of light, the subject being denoted by the term "photophoresis."

Those scientifically interested in the subject of smoke, or desiring to be generally informed in this respect, will find the book a valuable addition to their libraries.

German Hydraulic Research

PAPERS OF THE INSTITUTE OF HYDRAULIC MACHINERY, TECHNICAL HIGH SCHOOL, KARLSRUHE, GERMANY; PART II. *Edited by Prof. W. Spannhake. Published by the V.D.I.-Verlag, Dorotheenstr. 40, Berlin NW. 7, Germany; 1932. Paper, 7x10 in.; 175 pages, 108 illustrations. Price, 4 marks.*

WRITTEN in German, this publication contains four papers: One by E. Weinel on "Hydrodynamics of Ideal Circulating Flow"; another on "Turbulent Flow Through Pipes of Circular Cross Section"; a third on "Investigation of Flow in a Rotating Hollow Space"; and the fourth, "Investigations of Draft Tubes for High-Speed Turbines." These papers are highly theoretical and present information on the flow of water that has not been published before and cover work done in the hydraulic laboratory of the Technical High School at Karlsruhe. The paper on draft tubes gives the results of experiments with various forms used with an adjustable blade propeller-type turbine. The draft tube is of the straight conical type. In some of the experiments a central cone was used in the draft tube; in others, vertical guide vanes were placed at the bottom of the tube. The effects of vertical piers of various shapes in the horizontal discharge from the tube were also investigated.

Standardization Activities

1932 STANDARDS YEARBOOK. *Compiled and published by the United States Bureau of Standards. Cloth, 6x9 in.; 394 pages, charts and tables. For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.; price, $1.*

The increasing importance placed upon standardization by many foreign governments and world-wide developments along this line, as well as various other scientific achievements, are discussed in the "1932 Standards Yearbook." Considerable detail is also given on standardization work being done in the United States.

Subjects covered in the book range from accident prevention to zoning systems and include references to important work having a direct bearing on reducing the cost to the public and increasing the profit of manufacturers of a wide range of articles. Other sections of the book contain brief reports of the work of standardizing bodies within the federal government and of states, counties and municipal agencies, as well as technical societies and trade associations.

The book contains numerous evidences of the value placed upon standardization in many lines of commerce and industry. From the standpoint of safety of life alone, the work being carried on in various lines of transportation to standardize signals and warning devices is very important.

Rewinding A.C. Motors

REWINDING AND CONNECTING ALTERNATING-CURRENT MOTORS. *By Daniel H. Braymer and A. C. Roe. Published by the McGraw-Hill Book Company, 330 West 42d St., New York City; 1932. Cloth, 6x9 in.; 372 pages, 71 tables and 228 illustrations. Price, $3.50.*

WINDING alternating-current motors embraces a great many ramifications, a wide variety of which have been covered in this book. The material has been arranged to serve as a reference to practical procedure in applying and checking lap and wave winding in both stators and rotors. Winding for single-, two- and three-phase motors comprises the major part of the treatment.

Of the 27 chapters the first seven are devoted to operating principles of alternating-current motors and how to lay out windings for these type of motors. These are followed by eight chapters on windings for single-speed motors.

S BOOKSHELF

Windings for multi-speed and double-voltage motors are covered in three chapters. Other chapters tell how to change induction-motor windings so as to make them satisfactory for operation on a voltage or frequency other than that for which they were designed. How to change single-phase motors for operation on a three-phase circuit is the subject of one chapter, and rotor windings are treated in three chapters.

A great mass of winding data is given in the 71 tables that form an important part of the book. Among these are ten giving winding data on wave winding for from four to twelve poles in two-phase and three-phase motors. Twenty-three tables give multipliers to use when regrouping windings for a change in frequency. Another group of tables gives data on rotor windings.

The authors of this book have written a number of exceedingly useful and practical books on armature winding. This, their latest effort, measures up to their previous standards and should find a wide clientele among those interested in windings for alternating-current motors.

Electrical Handbook Revised

AMERICAN ELECTRICIAN'S HANDBOOK. *By Terrell Croft. Revised by Clifford C. Carr, department of electrical engineering, Pratt Institute. Published by the McGraw-Hill Book Company, 330 West 42nd St., New York City; 1932. Semi-flexible binding, 4x7 in.; 1,051 pages, 831 illustrations, numerous tables. Price $4.*

WHEN COMPILING the first edition of this book the aim was to collect and present such information as would enable electrical workers and operating engineers intelligently to select and install electrical equipment. In this, the third edition, the original idea has been adhered to in bringing the material up to date. More than 200 pages of new material including 150 new illustrations and many tables have been added and the work has been brought into agreement with the requirements of the 1931 edition of the National Electrical Code.

Of the new material added to this edition mention will be made of some of the valuable tables that are included. A table on the characteristics of motors, which covers ten pages, gives the types of motors; horsepower rating; speed characteristics; speed control; starting characteristics when started in the usual manner and when started to develop the maximum torque; and the general applications for which the motors are suited. A table "Guide to Selections of Type of Motor," gives the load requirements, both when starting and running; and the types of motors that are suitable to these loads.

Other tables give representative applications of different types of motors. There are 45 tables giving specific information on the sizes of motors to drive various types of machines. Another group of tables shows the size of wire, conduit, switches and overload-protective devices for various types of motors.

These tables add materially to the practical value of this handbook and extend its usefulness not only to practical electrical workers but to technically trained engineers.

Machinist Handbook

AMERICAN MACHINISTS HANDBOOK. *Fifth Edition. By Fred H. Colvin and Frank A. Stanley. Published by the McGraw-Hill Book Company, 330 West 42nd St., New York City; 1932. Flexible binding, 4x7 in.; 1135 pages; diagrams and tables. Price, $4.*

THOROUGHLY REVISED and enlarged, this standard work reflects combined efforts of the authors and of well-known engineers. Their task has been a difficult one, for the many changes in shop practice during the five years since the last edition have necessitated a number of additions to the book which almost threaten to take it out of the "handbook" classification.

In addition to its purely machinist information, it includes such material as screw threads, pipe threads, knots and slings, horsepower, belts and shafting, measuring and fitting, brazing, soldering and welding, bolts, nuts and screws, reference tables, and shop trigonometry, which should recommend the work to the power engineer. Language is simple and easily understandable. Information is as accurate as careful checking and revision can make it.

BRIEF REVIEWS

THE STRENGTH AT HIGH TEMPERATURES OF A CAST AND A FORGED STEEL AS USED FOR TURBINE CONSTRUCTION. By H. J. Tapsell and A. E. Johnson. Published as Special Report No. 17 by the Department of Scientific and Industrial Research of Great Britain; 33 pages, illustrated. For sale by the British Library of Information, 270 Madison Ave., New York City; price 20c.—A report on the creep properties of certain turbine steels at temperatures above 400 deg. Centigrade.

TESTS ON THE CONTINUOUS CARBONIZATION OF FINELY CRUSHED COAL BY RADIANT HEAT. By Floyd B. Hobart and D. J. Demorest. Published as Bulletin No. 65 of the Engineering Experiment Station, Ohio State University, Columbus, Ohio; 39 pages, illustrated; price 50c.—Results of coal carbonization tests conducted by the Experiment Station in cooperation with the Battelle Memorial Institute.

AN OSCILLOGRAPHIC STUDY OF TRANSFORMER CHARACTERISTICS. By G. V. Mueller. Published as Bulletin No. 37 of the Engineering Experiment Station, Purdue University, Lafayette, Ind.; 32 pages, illustrated; price 35c.—This study discusses the theories of transformer operation illustrated by oscillograms and explains why certain connections of transformers are undesirable.

THE USEFULNESS OF MATHEMATICS TO ENGINEERS. By P. W. Ott. Published as Circular No. 27 of the Engineering Experiment Station, Ohio State University, Columbus, Ohio; 15 pages, illustrated; free.—A sprightly discussion of arithmetic, algebra, geometry, trigonometry and calculus as progressive steps in the proper mathematical training needed for the solution of engineering problems.

THE HOLDING COMPANY. By James C. Bonbright and Gardner C. Means. Published by the McGraw-Hill Book Company, 330 West 42d St., New York City; 384 pages, illustrated; price $4.—A complete picture of the organization, operation, as well as social and political significance of the holding company in the industrial, utility, railroad and banking fields.

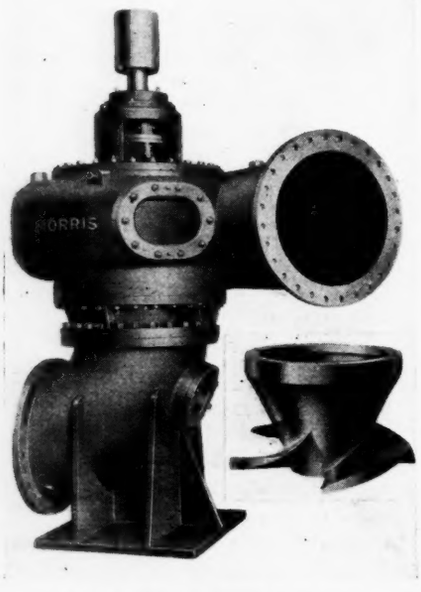
GASOLINE AUTOMOBILES. By James A. Moyer. Published by the McGraw-Hill Book Company, 330 West 42d St., New York City; 509 pages, illustrated; price $2.75.—All important recent changes in design and practice have been included in the fourth revised edition of this widely used book on the essential principles of modern gasoline automobile construction and operation.

TECHNICAL PAPERS published recently by the Institute of Fuel, 53 Victoria St., London, S. W. 1, England, include: "The Conditioning of Boiler Feed Water," by V. B. Harley-Mason, chief engineer of the Manchester Steam Users Association; "The Evaluation of Fuel From the Consumers' Viewpoint," by Dr. E. S. Grumell; and "Review of the Methods of Dust Removal From Power Station Flue Gases," by J. Mayer.

WHAT'S NEW IN PLANT EQUIPMENT

Propeller Type Pump for Drainage and Condenser Circulating Service

A PROPELLER type pump for handling sewage, storm water, general drainage or condenser circulating service, is announced by Morris Machine Works, Baldwinsville, N. Y. The propeller is of the screw type with widely spaced



Morris ventical pump and type of propeller used

open vanes which pass solids of large size without danger of clogging. The design also permits delivering large quantities of water at low heads when operating at comparatively high rotative speeds, so that on low-head services the pump is particularly suited for direct motor-drive.

The casing has a large handhole opening for inspection of the interior and is provided on both sides with renewable disks, which maintain close clearances with the propeller. The pump is built in sizes 16 in. and larger, and for horizontal or vertical drive

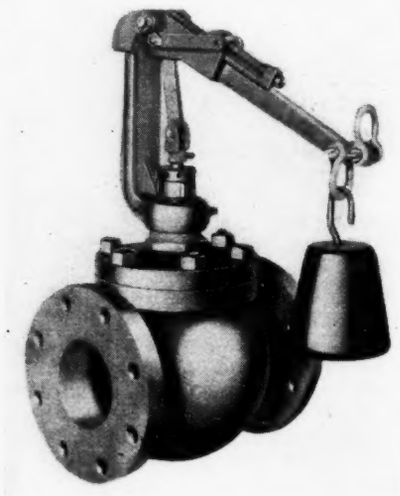
Coated Electrodes

UNLIKE most coated electrodes, the hi-tensile electrode put out by Page Steel & Wire Company, Monessen, Pa., does not require reverse polarity for efficient operation and high speed. However, if reverse polarity is used, even faster speeds may be obtained. The arc is free burning, the molten pool of metal can be readily observed, and the amount of metal deposited can be judged accurately.

The grain structure of the weld is essentially the same as that of mild steel and boiler plate base metal. The electrode results in deep penetration, and the strength of the finished weld is said to be equal to that of the base metal with a total elongation of over 30 per cent when pulled to destruction. The finished weld is ductile and responds readily to heat-treatment.

Lever-Operated Control Valve With Adjustable Port Opening

LEVER-OPERATED control valves fitted with parabolic type gradual opening bevel seats, capable of being adjusted



Atlas lever-operated control valve

for any maximum port opening that the load demands, have been added to the line of regulating valves put out by Atlas Valve Company, 282 South St., Newark, N. J.

The valves, which provide a progressive increment of port opening proportionate to the travel of the controlling mechanism, are suitable for use on air, gas, oil, water or steam and can be used with any standard control device or in combination with floats direct or pilot operated for the control of liquid levels.

Adjustment of the port opening to control mechanism travel is done by means of the adjusting screw mounted on the lever. Turning the screw changes the radius through which the valve stem travels, which in turn sets the ratio of valve stem travel to operating lever travel. Another feature of the valve is that it may be set for minimum flow without the use of a bypass.

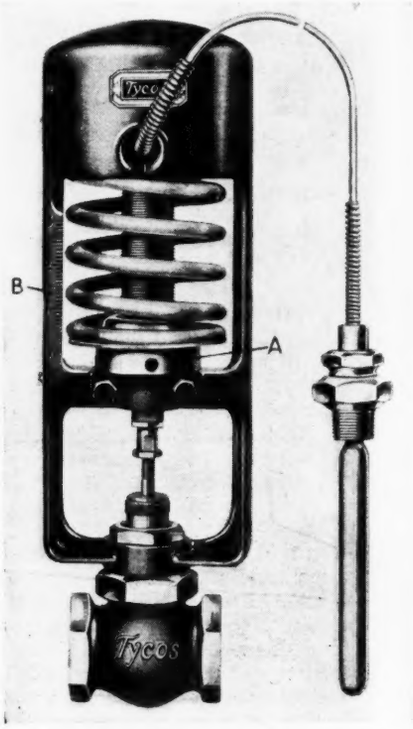
The valve is made with bronze bodies suitable for 300 lb. working pressure in sizes from $\frac{1}{2}$ to 2 in. and with cast-iron bodies for 250 lb. pressure, from $2\frac{1}{2}$- to 6-in. sizes. Valves can be furnished of special metal where the service requires it.

Improved Self-Acting Temperature Regulator

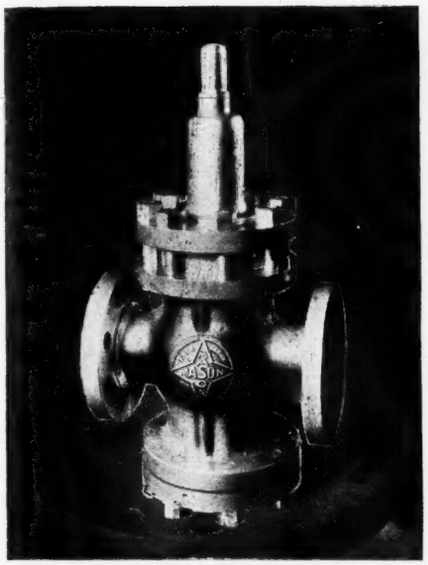
CLOSE control with quick response and sensitivity are claimed for the "Tycos" self-acting temperature regulator put out by the Taylor Instrument Companies, Rochester, N. Y.

The improved operation of the regulator has been made possible through the practical elimination of friction, thereby permitting the valve to respond readily to changes in temperature at the bulb. In the new instrument the "dead period" has been practically eliminated, and the valve moves simultaneously with the temperature change, giving the desired throttling control.

Improvements have also been made in the construction of the tube system. This consists of a double seamless bellows, extra-heavy walled copper connection tubing and a stainless steel bulb of small size and thin wall.



Tycos self-acting temperature regular



Mason reducing valve for 600 lb. pressure and 750 deg. temperature

Reducing Valve for High-Pressure, High-Temperature Service

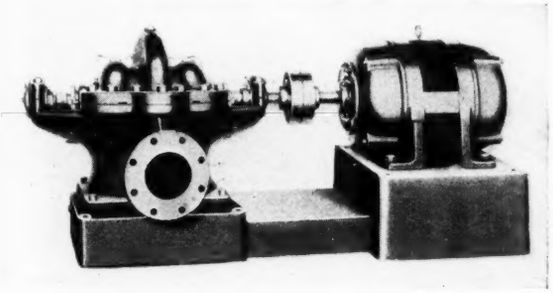
DESIGNED especially for use on high-temperature service, a reducing valve brought out by Mason Regulator Company, 1190 Adams St., Boston, Mass., embodies a new type of valve design which, it is claimed greatly reduces flow turbulence and wire drawing in extreme service. The valve body is cast of chrome-molybdenum steel and has a high tensile strength suitable for initial pressures up to 600 lb. and total temperatures of 750 deg. F.

The main and auxiliary valves are made of nitralloy, and other moving parts are machined from stainless steel, heat-treated to provide the necessary degree of hardness. The valve is readily disassembled, and the alloy-steel springs provide exceptionally wide pressure ranges.

Centrifugal Pump of Improved Design

THE centrifugal pump designated Fig. 5803, recently announced by Fairbanks, Morse & Company, 900 South Wabash Ave., Chicago, Ill., is of split-case design with stream-lining of flow both in the impeller and casing, which reduces any tendency toward cavitation. The pump is designed for a wide range of suction and discharge conditions.

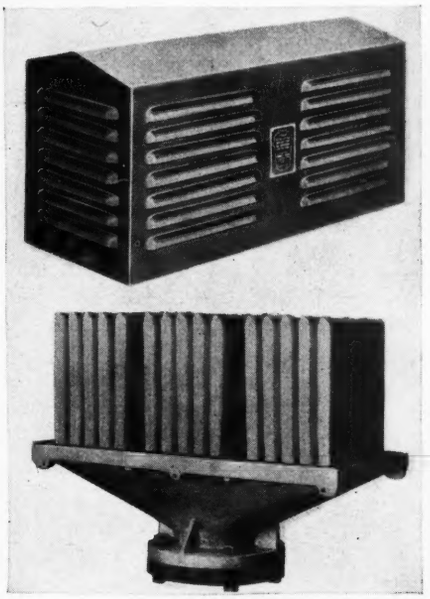
Mechanical features include: a cartridge-type ball bearing element removable without disturbing the alignment or introducing dirt or grit into the bearing housing, improved stuffing boxes and wearing rings both for the casing and the impeller, improved methods of locking the rings to prevent rotation.



Fairbanks-Morse Fig. 5803 centrifugal pump

Dry Type Air Filter

THE ANNIS air filter, developed by Coppus Engineering Corporation, 349 Park Ave., Worcester, Mass., for use on air intakes of compressors, internal combustion engines and similar services, is the "dry" type made in standard units, permitting assembly to give any desired capacity.



Annis multiple-element air filter

Each filter unit consists of a spacer frame made up of a series of five loops of wire, over which a wool felt filter element is fitted. A large area of filter surface in each unit is thus obtained.

Over each unit is slipped a spreader grid bolted to an aluminum base plate holding groups of units sufficient to make up the desired capacity. The grid holds the felt element tautly against the wire spacer frame, but at the same time permits the unit to be quickly detached and replaced. Base plates are provided with screw thread or pipe flange connection, depending on size of pipe. Each complete filter is enclosed in a weatherproof enameled sheet metal cover suitable for out-door erection without need of additional housing. Louvres or similarly protected openings in the housing provide for proper air admission.

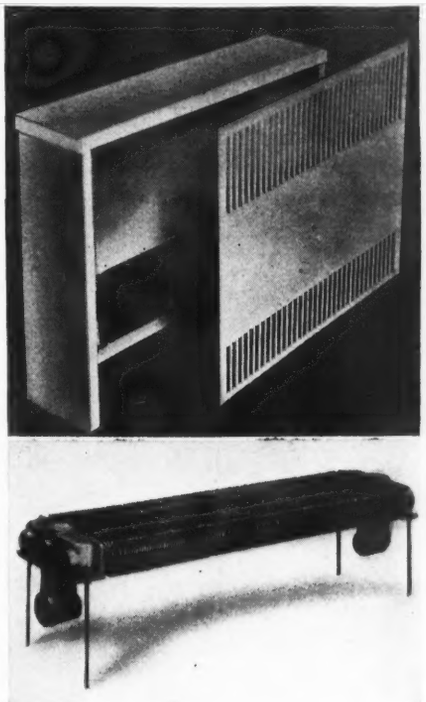
The filters are easily cleaned, without removal from position, either by blowing the dust and dirt off the filter elements or with a vacuum cleaner.

Built-In Heaters for Vapor and Vacuum Heating Systems

THIS built-in type heater is designed to take the place of the standard radiator on two-pipe steam, vapor and vacuum heating systems.

Known as "Convectofin," the unit operates on the convestion heating principle rather than by radiation. A heating element with headers of one-piece cast construction connected by finned tubes is inclosed in a steel cabinet, the front panel of which has an inlet and outlet grille. In operation, air in the cabinet is heated by the steam element and a draft is created, drawing the cooler air through the inlet grille from the floor level.

In the standard combination illustrated, the headers of the heating element have face outlet, ell shape, of the drop type or underslung, permitting the piping connection to be made entirely within the space of the cabinet.



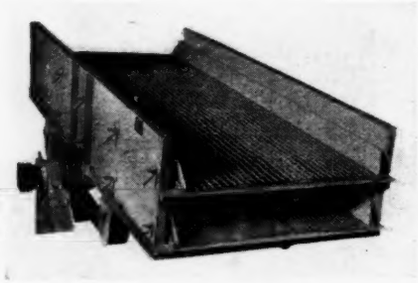
Heater with front panel removed, and separate view of heating element

Many combinations and designs of cabinets and heating elements are available. The heater is manufactured by Commodore Heaters Corporation, 11 West 42nd Street, New York City.

Heavy-Duty Vibrating Screens

Two new types of vibrating screens, known as positive-drive-type and unbalanced-pulley-type, have been announced by Link-Belt Company, 2045 West Hunting Park Ave., Philadelphia, Pa.

In the positive-drive-type screen, amplitude of vibration is fixed at the factory to suit the work the screen is to do. Any given amplitude will cover a wide range of screening surface openings. The angle of the screen inclination, the speed of operation and the direction of the rotation all are readily changed to suit the kind, size and condition of material to be screened. The rotation determines whether the vibrations are with or against the flow of the material.



Link-Belt double-deck eccentric-type vibrating screen

Cantilever leaf springs serve to maintain the screen box at a constant angle, being adapted for the circular motion produced by the action of the eccentric-driven positive drive. Oversize self-aligning spherical roller bearings are used.

The unbalanced-pulley-type is available with single or multiple decks, for high-speed work where the material is of a sticky nature, and on close-sizing problems where the screen openings are not large.

The total movement, or amplitude, of the screen can be varied by the user from zero to about ¼ in. simply by changing the counterweights in the weight containers. The angle of the screen and the speed and direction can also be changed readily by the user to suit operating conditions. A flat belt or V-belt drive is employed.

Portable Pipe Threader and Work Stand

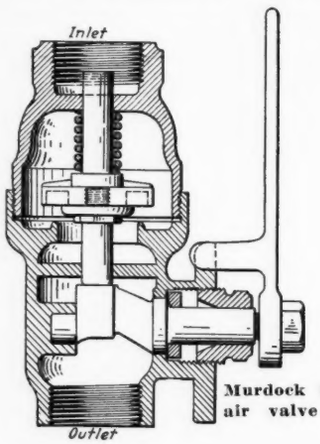
Several items have been added recently to the general threader line put out by Axelson Manufacturing Company, Los Angeles, Calif. One, illustrated, is a large die stock power driven from the Axelson portable threader by means of the universal joint equipped extension shaft. One end is adapted to take the drive from the head of the machine; the other end has a square socket to suit standard die stocks. Another accessory is a portable work stand equipped with wheels and extension handles. A convenient drawer and base shelf allow ample space for tools, dies, attachments, etc. Adapters are available to hold bolt dies, as well as adapter jaws to hold bolts of smaller diameter than the standard jaws will take.

Axelson portable pipe threader

Quick-Opening Compressed Air Valve

Although designed primarily for use on railway equipment, the compressed-air valve illustrated is now being introduced into the industrial field by Murdock Manufacturing & Supply Company, Cincinnati, Ohio.

Designed for quick opening and closing, the valve is either full on or full off and cannot be left in a partly open position. In the closed position the disk is held to the seat by the pressure only and the cam is disengaged from the stem. The spring shown on the stem above the disk is an auxiliary in case the valve is installed in horizontal or inverted position. The valve disk is renewable.

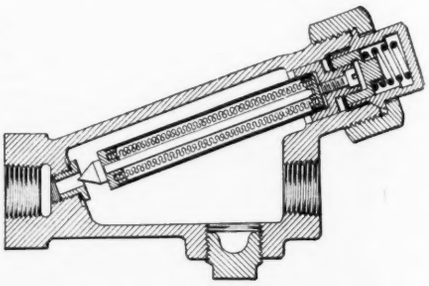


Murdock Q.O.C. air valve open

The valve is made of red brass and fitted with hard bronze camshaft and steel handle. It is made in sizes from ½ to 2 in.

Steam Trap with Outside Pressure Adjustment

Although developed primarily for railroad service, the Sarco No. 8 trap is equally well adapted to services in industrial plants. It is provided with outside pressure adjustment with locking device and has a straightway as well as angle connection.



Sarco No. 8 steam trap

The relief spring for the expansion element or cartridge is built in, which is said to prolong the life of the trap where pressures fluctuate. Other features of the design will be apparent from the illustration. The trap is manufactured by Sarco Company, Inc., 183 Madison Ave., New York City.

Multiple-Fan Ventilating Units

Some of the services to which the Shortboy electric ventilating units, developed by Buffalo Forge Company, 493 Broadway, Buffalo, N. Y., are particularly suited are ventilating transformers or generator rooms, furnishing air circulation for dryer compartments, as booster fans in cramped quarters, and other applications where headroom is limited. Fan elements are of the multi-blade type, and units can be furnished with one, two, three or four fans, all arranged on the same shaft and direct connected through a flexible coupling to one driving motor. They can be arranged for either top, side or bottom discharge, opposite to or at 90 deg. to the intake.

Complete units are made in seven sizes. Two types of multi-blade wheels are available, one for slow speed, the other a medium-speed backward curved blade design which has a rising pres-

Buffalo "Shortboy" electric ventilating unit with multiple fans

sure characteristic and is best suited for industrial applications. Each individual rotor is complete with a centrifugal type housing, and the bearings and motor are entirely outside of the air flow, making the unit particularly suited to applications where dirty air or corrosive gases are handled. Ball bearings are standard squipment.

Electrographitic Brush for Heavy-Duty Direct-Current Generators

NATIONAL Pyramid Grade No. 234 designates a new electrographitic brush announced by National Carbon Company, Inc., Cleveland, Ohio. Developed for use on heavy-duty direct-current generating and substation equipment, the non-resilient structure of the brush is said to cause it to maintain firm contact on commutators of high peripheral speed. Other claims are low friction and high carrying capacity combined with the smooth riding properties which minimize brush wear and commutator maintenance.

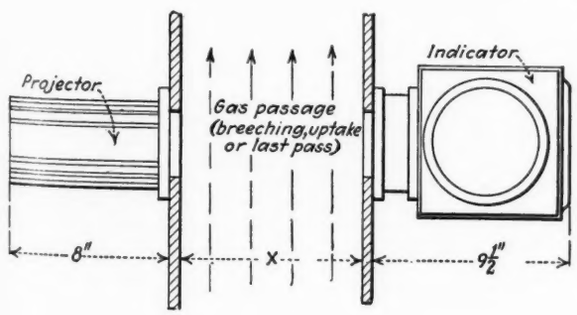
Boiler Smoke Indicator

TO MEET the need for a moderate priced smoke indicator suited for installation in the many different conditions encountered in boiler rooms, the instrument shown has been developed. The principle of the instrument consists in projecting a beam of light across a smoke passage and allowing it to fall on a special shadow screen on the opposite side. Shadows formed vary in density with the density of smoke in the passage.

The projector and indicator head are cast aluminum. The indicator head is arranged so that the shadow screen may be placed along the axis of the beam, at 45 deg. or at 90 deg. to it, thus allowing for flexibility in mounting. The indicator head may also be rotated around the axis of the beam in any desired direction. Images of the shadow screen may be reflected to any desired point by means of ordinary mirrors or by use of a special 90-deg. reflector.

In cases where it is impossible to install the projector on the back of the smoke passage, a modification whereby the projector and indicator are both mounted on the front and the beam reflected from the back by a mirror has been developed. Other modifications permit the instrument to be installed at any desired point and used as a sampling type indicator, if so desired.

The instrument is put out by C. C. Sheppard, 75 Church St., New York City.

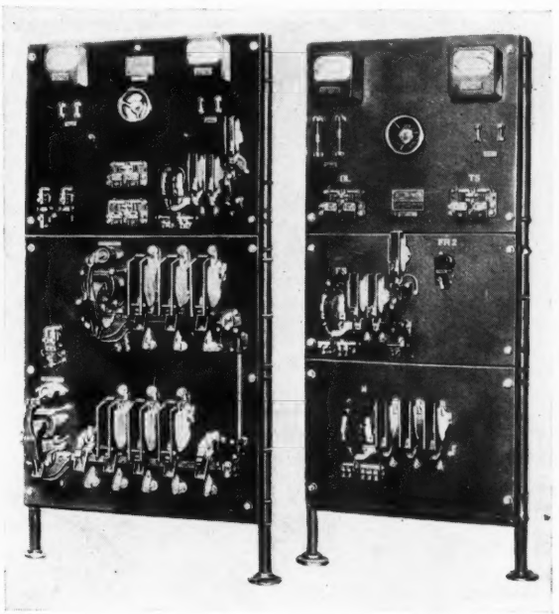


Smoke indicator projects a beam of light across the smoke passage and causes it to fall on a shadow screen on the opposite side

New Line of Fire Brick

LACLEDE Mullite is the name given to a new line of refractories announced recently by Laclede-Christy, St. Louis, Mo. It is a crystalline combination of silica and alumina.

Resistance to spalling caused by temperature changes, ability to withstand very high temperatures without shrinking or deforming and resistance to attack of molten slags are some of the properties claimed for this new fire brick. It is also said to have a high load bearing capacity, and due to its high refractoriness its fusion point is cone 34. A special Mullite-Base cement, Setskold C-7, has also been developed for use with the brick. It is an air setting mortar and is available in 100, 200 and 500-lb. metal drums. For cases where it might be desirable to use a chrome mortar, Laclede chrome mortar with air drying properties has been made available in 150-lb. drums.



Automatic, reduced-voltage type and automatic, full-voltage type starters

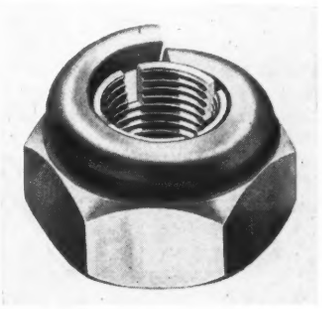
Starters for Synchronous Motors

IMPORTANT in the operation of the new line of automatic and semi-automatic starters for synchronous motors, which have just been developed by Cutler-Hammer, Inc., 294 No. 12th St., Milwaukee, Wis., is a frequency responsive relay which functions in connection with an adjustable time delay thermal overload relay. In the case of either heavy overload, reduced line voltage, failure of motor field or loss of excitation, the frequency relay disconnects the field switch and permits the motor to operate as a squirrel cage motor for a period of about 30 seconds, depending upon the setting of the thermal overload relay. Should normal conditions return within the time adjusted for, the motor will re-synchronize and continue in operation—otherwise it will be disconnected from the line. This frequency relay also controls the field excitation automatically, and on the reduced voltage automatic type it governs the transfer from low starting voltage to full voltage.

These new starters are made in sizes from 25 to 600 hp. for voltages of 220, 440, 550 and 2,200.

Self-Locking Locknuts

THIS "Dalwa" locknut is assembled into a single working unit. A conical groove on the nut seating face surrounds part of the threaded portion, which is divided into four equal segments by slots. The compensator is an elastic steel washer shaped to fit into the groove. When the nut is drawn up, the compensator fills the conical groove in the nut, but at the start the included angle in the conical groove is smaller than the angle on the compensator. Thus, the four threaded segments are pressed into the bolt thread. The nut is made by International Safety Lock Nut Corporation, 67 Broad St., New York City.



NEWS of the WEEK

A.I.E.E. Summer Convention At Cleveland, June 20-24

A DIVERSIFIED PROGRAM of five technical sessions, inspection trips, entertainment and outdoor recreation has been arranged for the annual summer convention of the American Institute of Electrical Engineers, which will be held this year at Cleveland, Ohio, on June 20 to 24, with headquarters at the Hotel Cleveland.

Two symposiums and seven technical sessions are scheduled on the program, which contains many papers covering a wide variety of interesting subjects in the field of electrical engineering. One symposium will be devoted to a discussion of the combined aspects of reliability and economy in the operation of large electric systems, while the other will be on conductor vibration. Covering system operating practice in four different localities, the papers to be presented at the first symposium are: "Philadelphia Electric Company's System," J. W. Anderson and Herbert Astrada; "Detroit Edison Company's System," A. P. Fugill; "Edison Electric Illuminating Company of Boston's System," R. E. Dillon; and "Chicago District," L. L. Perry and F. V. Smith.

Subjects to be discussed at the seven other sessions include electrical machinery, electrochemistry-electrometallurgy, research, protective devices and automatic stations. Among the papers that will be read are: "Coordination of Transformer Insulation With Line Insulation," W. M. Dann; "Load Ratio Control Circuits," L. F. Blume; "Influence of Brush Contact Drop on Commutation," L. R. Ludwig and R. M. Baker; "Single-Phase Short-Circuit Torques of Synchronous Machines," C. A. Nickle and M. L. Henderson; "Transient Analysis of A.C. Machinery II: Extension to Salient-Pole Machines," Y. H. Ku.

"Induction Motor Versatility—The Nature of Its Applications," E. W. Henderson; "Dynamic Braking of Synchronous Machines," E. E. Kilbourne and I. A. Terry; "Application of High-Speed Relays," G. W. Gerell; "A High-Speed Reactance Relay," A. R. van C. Warrington; "Relay Operation From Bushing Potential Devices," P. O. Langguth and V. B. Jones; "The Boric Acid Fuse," A. P. Strom and H. L. Rawlins.

District Heating Association to Meet in Pittsburgh, June 14-17

Program has just been announced for the 23rd annual convention of the National District Heating Association to be held on June 14 to 17 in Pittsburgh, Pa., with headquarters at the William Penn Hotel. Six business and technical sessions are scheduled for the meeting, together with a full complement of entertainment features.

Committee reports of particular interest include: Report of Commercial Relations Committee, S. S. Sanford; Report of the Pure Air Committee, J. H. Walker; Report of Meters and Accessories Committee, E. A. Lueky; Report of Station Operating Committee, H. J. Bauer; Report of Hot Water Committee, R. C. March; Report of Operating Statistics Committee, A. D. Leach; Report of Distribution Committee, J. F. Collins, Jr.; and Report of Research Committee, E. E. Dubry.

Among the papers to be given in the station operating distribution reports are: "Selection and Utilization of Fuels," J. R. McCausland; "Operating Experiences With Pease-Anthony Gas Scrubbers," M. D. Engle; "Continuous Blow-Down Systems," A. R. Mumford; "One Method of Estimating Peak Demands on a Steam Heating System," R. G. Felger; "Distribution Line Losses and Unaccounted-for Steam," Edward Lenz; "Comparison of Standard Conduits," R. M. Nee; "Comparison of District Heating System Designs," L. D. Gray.

A new feature of the program this year is the entire session devoted to a manufacturers' round table, at which the latest developments in equipment, new methods of construction and ways of improving existing apparatus will be discussed by representatives of the manufacturing companies.

Largest Synchronous Condenser For Commonwealth Edison Co.

A 75,000 kva., 514 r.p.m. synchronous condenser is being built by the Westinghouse Electric and Manufacturing Company for the Commonwealth Edison Company, Chicago. Larger by a half than any other condenser, this unit will be connected through transformers to the 220-kv. line which transmits 150,000 kw. into Chicago (Crawford Ave station) from the Powerton station, 150 miles away. The machine is 40 ft. long, 16 ft. in diameter and weighs over 300 tons. The main machine is fitted with a direct-connected, 3,750-hp. induction motor for starting and synchronizing. This motor will also be used to drive the condenser as a generator for testing the transmission line.

COMING MEETINGS

American Society of Mechanical Engineers—Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting, Pennsylvania State College, June 8-11. C. W. Rice, 33 West 39th St., New York.

American Institute of Electrical Engineers—Cleveland, Ohio, June 20-24. Headquarters, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers—Hotel Pfister, Milwaukee, Wis., June 27-29. A. V. Hutchinson, 51 Madison Ave., New York.

American Society for Testing Materials—Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Society of Refrigerating Engineers—Massachusetts Institute of Technology, Cambridge, Mass., June 9-11. D. L. Fiske, 37 West 39th St., New York.

National District Heating Association—William Penn Hotel, Pittsburgh, Pa., June 14-17. D. L. Gaskill, Greenville, Ohio.

A.S.H.V.E. to Meet in Milwaukee, June 27-29

THE SEMI-ANNUAL MEETING of the American Society of Heating and Ventilating Engineers will be held on June 27 to 29 in Milwaukee, Wis., with headquarters at the Hotel Pfister. Technical sessions are scheduled for the mornings, with the afternoons and evenings devoted to outdoor sports, sightseeing trips, dinners and dances.

Among the papers to be presented at the technical sessions, the following are of interest to the power field: "How to Use the Effective Temperature Index and Comfort Charts (Report of Technical Advisory Committee on Restudy of Comfort Chart and Comfort Line, C. P. Yaglou, chairman)"; "Investigation of Air Outlets in Classroom Ventilation," G. L. Larson, D. W. Nelson and R. W. Kubasta; "Thermal Properties of Building Materials," F. B. Rowley and A. B. Algren; "Tests of Convector Heaters in the Warm Wall Booth," M. K. Fahnestock and E. L. Broderick; "Loss of Head in Copper Pipe and Fittings," F. E. Giesecke and W. H. Badgett; "Automatic Gas Burners," C. G. Segeler; and the report of the Committee on Ventilation Standards, W. H. Driscoll, chairman.

Postpone Completion of New Seal Beach Steam Unit

Completion of an additional 50,000-hp. generating unit at the Seal Beach steam station of the Los Angeles Gas and Electric Corporation, construction of which was begun in February this year, will be deferred until re-establishment of satisfactory load conditions warrants additional generating capacity, according to H. L. Masser, vice-president and executive engineer of the corporation. Present work on the unit will end with completion of the foundation structure.

Announcement of plans for the new unit, to increase the capacity of the Seal Beach station to 148,000 hp., was made in October last year. Estimated cost of the project was $3,500,000, to include the cost of an addition to the station, the new unit, new transmission line and new substation facilities.

Permit Granted for 26,000-Hp. Project on Current River, Mo.

The Federal Power Commission authorized May 20 the granting of a preliminary permit to Current River Power Company of Kansas City, Mo., for a proposed power project above Doniphan on Current River in Ripley, Carter, and Shannon counties, Mo. At the same time, the commission rejected a conflicting application for a smaller project near the same site submitted by Doniphan Hydro-Electric Company of Doniphan, Mo.

According to the application, the Current River Power Company proposes the development of three power sites on Current River known as the Hargus Eddy,

Mill Creek, and Blair Creek sites. The power capacity of the combined project as computed by the district engineer of the War Department is about 26,000 hp. The Current River Power Company's plan proposes solid concrete dams of the gravity type ranging from 84 to 104 ft. in height.

The application of the Doniphan Hydro-Electric Company was rejected on the ground that the Current River Power Company plan provides for a more comprehensive development of the water resources and also because of the questionable safety of the hollow concrete dam proposed by the Doniphan company.

Annual Meeting of A.S.T.M. At Atlantic City, June 20-24

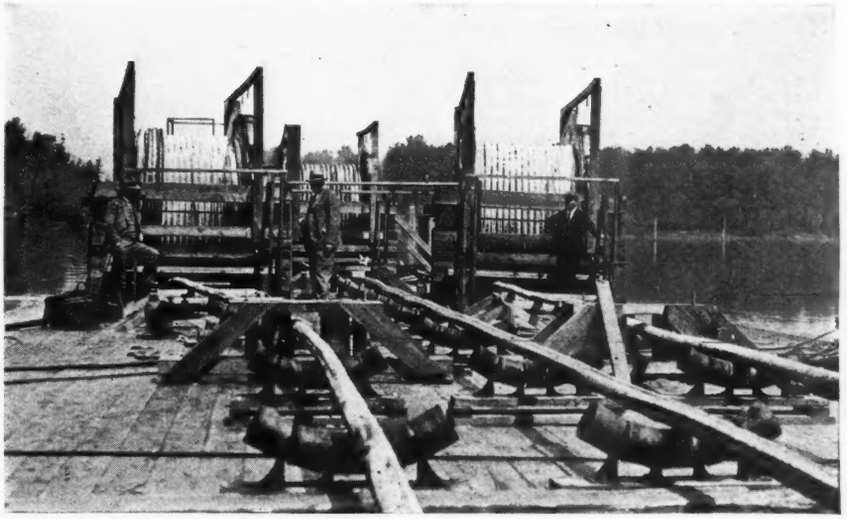
The American Society for Testing Materials will hold its 35th annual meeting at Chalfonte-Haddon Hall in Atlantic City, N. J., June 20 to 24. Fourteen sessions, including a symposium on steel castings and one on textiles, are scheduled on the program, along with the usual recreation and social events.

Reports and papers of interest to the power field include: "Iron-Chromium, Iron-Chromium-Nickel and Related Alloys," Jerome Strauss, together with the committee report on this subject; "Fusion Welding as Related to Steel Castings," T. S. Quinn; "Testing of Rope Wire and Wire Rope," A. V. de Forest and L. W. Hopkins; report of Committee A-1 on Steel; report on "Standardization of Dimensions and Material of Wrought-Iron and Wrought-Steel Pipe and Tubing"; report on electrical insulating materials; report of Joint Research Committee of A.S.M.E. and A.S.T.M. on Effect of Temperature on the Properties of Metals; report of Committee C-8 on Refractories; and "Mechanical Properties of White-Metal Bearing Alloys at Different Temperatures," H. K. Herschman and J. L. Basil.

Bids Received for Completion of Diablo Hydro-Electric Project

Bidding $1,744,705, a sum $399,473 less than the second low bidder, Bayley Hipkins, Inc., Seattle, Wash., submitted the low bid to the board of public works of that city for the completion of the Diablo hydro-electric project, an improvement which had been estimated to cost between $1,500,000 and $2,000,000. Three bids were received for the work, the other offers coming from the Chatham Construction & Engineering Company and the Puget Sound Bridge & Dredging Company, both of Seattle. The Chatham company bid $2,144,178 and the Puget Sound Bridge & Dredging Company bid $2,772,036.

None of the bids was accompanied by a certified check nor a bid bond. Each firm specified 6 per cent interest on the bonds which will be proffered in payment for the work. The successful bidder, providing the award is made on the bids received, will be required to accept 1927 issue of light and power bonds to cover the cost of the work and $1,854,000 worth of 1930 light and power bonds to pay off existing indebtedness on the Diablo project.



Laying the highest voltage (115 kv.) submarine cable across the Columbia River between Vancouver, Wash., and Portland, Ore., as a major link in the transmission line from Ariel hydro-electric plant on the Lewis River to Albina substation, Portland. Built by the Phoenix Utility Company for the Northwestern Electric Company, the line is scheduled to go into service this month

Los Angeles Power Commission Contributes $100,000 to Needy

Needy persons of Los Angeles, Calif., have been assured of additional aid as the result of a second appropriation of $50,000 from the municipal water and power funds to the Community Chest. Representatives of the chest requested an appropriation of $150,000 but members of the water and power commission agreed to appropriate only $50,000, having recently given a similar sum. It was indicated that the additional $100,000 requested might be appropriated for chest uses within the next three months.

Ask Power Bids on Construction Of Colorado River Aqueduct

The Metropolitan Water District of Southern California has just published notice inviting bids for furnishing electric power for the construction of the proposed Colorado River aqueduct. The invitation calls for bids on three items of power, the bids to be opened June 15 at the offices of the district in Los Angeles, Calif.

Item one on which bids are invited is for supplying 4,000 kw. at Lakeview; 4,000 kw. at Cabazon; 5,000 kw. at Fan Hill; 4,000 kw. at Hayfield and 4,000 kw. at Iron Mountain, all power to be delivered at approximately 33,000 volts. Also, upon request of the district, this bidder would be required to furnish 4,500 kw. at Parker.

Item two asks bids for supplying maximum demands at 4,000 kw. at Lakeview, 4,000 kw. at Cabazon and 5,000 kw. at Fan Hill, at approximately 33,000 volts.

Item three is for supplying a maximum demand of 23,000 kw. at a substation within fifty miles transmission district of Cajalco reservoir site, also, upon request of the district, an additional 4,000 kw. at the point specified.

For full electrification, the maximum capacity required will be about 23,000 kw. and the estimated energy used about 240,000,000 kw.-hr. at the low-tension side of the substations. The district reserves the right to require a $400,000 bond to be posted by the successful bidder on item one, a $150,000 bond on item two and a $500,000 bond on item three.

PERSONALS

BLAKE R. VAN LEER, assistant secretary of the American Engineering Council, has been appointed dean of the College of Engineering, University of Florida, to succeed the late JOHN R. BENTON, who died in 1930. Widely known for his work in the field of hydraulics, Mr. Van Leer has had twelve years of teaching experience at the University of California, where he supervised over 40 research investigations in that field.

LEONARD E. GRUNDELL has been made chief inspector of the San Francisco branch office of the Hartford Steam Boiler Inspection and Insurance Company to fill the vacancy caused by the death of LON J. REED. Mr. Grundell joined the company in 1925 after extensive experience in municipal and construction engineering work, and in 1930 he was made a directing inspector.

HARVEY C. RENTSCHLER, director of research for the Westinghouse Lamp Company, was tendered a luncheon May 24 in the administration building of the Century of Progress, Chicago, by several men prominent in the public utilities field. Dr. Rentschler went to Chicago to inspect the world's fair site.

H. C. JENKINSON, formerly with the Beauharnois Construction Company, Beauharnois, Que., is now connected with the Dominion Construction Company at Fraserdale, Ont. Prior to going with the Beauharnois company he worked for the Alcoa Power Company, Arvida, Que., and before that with the American District Steam Company, North Tonawanda, N. Y.

How's Business?

The general level of production and trade, such as it is, has not shown any marked change in the past three months, after allowing for usual seasonal factors. A similar stability during the Spring period was evident in the two preceding years; but business was then at a much higher level, and the possibilities of further decline from the present position would seem to be considerably smaller. Commodity prices are still falling, but more slowly and with some scattered signs of stabilization in specific instances. Security markets have not yet reflected these symptoms. Financial sentiment has been somewhat steadied by speedier Congressional action on fiscal issues, but is nervous about prospective European political developments. Although Federal Reserve efforts to stimulate speedy credit expansion have been ineffective and are marking time, improvement in the banking position continues steadily. Electric power output, according to the N.E.L.A., was 1,425,-151,000 for the week ending May 28.—*The Business Week*, June 8.

BUSINESS NOTES

DOUBLE SEAL RING COMPANY, Fort Worth, Tex., announces that Glen E. Brown, formerly sales engineer for the Fulton Iron Works Company, has joined its sales organization. Mr. Bowen is in charge of the Chicago territory, comprising Illinois, Indiana and Wisconsin, with headquarters at 915 Glengyle Pl., Chicago.

BONNEY FORGE & TOOL WORKS, Allentown, Pa., has appointed D. H. Skeen and Company distributors in the Chicago district.

POOLE FOUNDRY & MACHINE COMPANY has been organized to conduct the former business and plant of the Poole Engineering & Machine Company, with general offices and works at Woodberry, Baltimore, Md. S. P. Brady is president, S. P. Brady, Jr., vice-president and L. M. Ricketts, secretary-treasurer.

HOMESTEAD VALVE MANUFACTURING COMPANY, Coraopolis, Pa., has appointed the Lietz Engineering Company, 2354 Lincoln Ave., Chicago, Ill., as exclusive representative in that district

RELIANCE ELECTRIC & ENGINEERING COMPANY, Cleveland, Ohio, has promoted R. H. Smith of the Boston office to manager of the development engineering department with headquarters in Cleveland. C. E. Robinson has been advanced to fill Mr. Smith's former position as manager of the Boston district office.

New Bulletins

GEAR DRIVES—Bulletin 425 on "Farrel-Sykes High-Speed Gear Units," Farrel-Birmingham Company, Ansonia, Conn.

COMPRESSORS, DIESELS, BELTS—Bulletin L-620-S2 on vertical single-cylinder two-stage air compressors; Bulletins S-500-S1 and S-500-S2 on stationary diesel engines; Bulletin L-400-B2A on multi-V-drives; Bulletin W-900-B9 on disc-type water meters, Worthington Pump and Machinery Corporation, Harrison, N. J.

AFTERCOOLERS—Bulletin 12-G (Supplement 1), compressed-air aftercoolers, Schutte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa.

DIESEL ENGINES—Bulletin 162, progress in marine diesels, Busch-Sulzer Bros.-Diesel Engine Company, St. Louis, Mo.

COMBUSTION METERS—Catalog RIE-32, automatic combustion indicators, Hays Corporation, East 8th St., Michigan City, Ind.

SUPERHEATERS—Booklet on services and products of the Superheater Company, 17 East 42nd St., New York, N. Y.

INSULATING CEMENT—Booklet on Eagle "66" insulating cement, Eagle-Picher Lead Company, Joplin, Mo.

WELDING FITTINGS—Bulletin WT17 on "Weldolets and Thredolets," Bonney Forge and Tool Works, Allentown, Pa.

BLAST GATES—Catalog 325, blast gates, W. S. Rockwell Company, 50 Church St., New York, N. Y.

New Plant Construction

Compiled by the McGraw-Hill Business News Department, Which Is Prepared to Furnish a More Complete Daily Service to Those Who Wish It

Calif., Alameda — Bureau of Public Roads, 461 Market St., San Francisco, will receive bids until June 9 for construction of units 12 and 13 of transformer station and distributor house exclusive of piling and other foundation work at Government Island here.

Conn., Bridgeport—Park City Ice Co., 558 Howard Ave., awarded contract for construction of a 2 story addition to ice plant to P. Frank Inc., 1438 Main St.

Ill., Hillsboro—City plans construction of a municipal light and power plant and distribution system. Estimated cost $200,000. Warren & Van Pragg, Decatur, are engineers.

Ind., Michigan City—Indiana State Prison, will build a refrigeration plant. Work will be done by owner's forces. $10,000.

Ind., Veedersburg—City is having plans prepared for construction of a new municipal light and power plant. Estimated cost $40,000. J. W. Moore & Son, 839 Pythian Bldg., Indianapolis, are engineers.

La., Shreveport—Independent Ice & Storage Co., awarded contract for installation of a refrigeration plant to York Ice Machine Co., 2201 Texas St., Houston, Tex.

Mass., Amesbury—Ideal Soft Water Laundry, awarded contract for additional unit to plant including boiler house on High St. to E. W. and P. B. Currier, 7 Sanborn Terrace, Amesbury.

Mass., South Hadley—Mount Holyoke College, M. E. Wooley, Pres., plans completed for construction of a 2 story, 50 x 100 ft. boiler house. H. French, 200 South St., Boston, is engineer.

Minn., Big Falls — City plans to rebuild waterworks pumping station destroyed by fire. Estimated cost to exceed $40,000.

Minn., Waconia—City will soon award contract for construction of electric power and light plant including power house, equipment and distribution system, etc. Estimated cost $25,000. G. M. Orr & Co., 408 Baker Bldg., Minneapolis, are engineers. Bids June 6.

Mo., Doniphan—Current River Power Co., Kansas City, has been granted preliminary permit by Federal Power Commission for installation of hydro-electric development on Current River near here including construction of a series of three dams. Owner proposes to expend $7,660,000 for two of these improvements. The first dam at Hargus Eddy has been estimated at $4,160,000; the second at Mill Creek, $3,500,-000 while no estimate has been made of the third contemplated dam at Blair Creek. The three projects would have a combined output of 26,000 hp.

Neb., Valley—City having plans prepared for waterworks improvements including well, pump house, pumping equipment, etc. Henningson Engineering Co., 326 Union State Bank Bldg., is engineer.

N. J., Newark—A. Fruh & Son, 810 Frelinghuysen Ave., awarded general contract for construction of a 1 story addition to cold storage plant to O. Joroff, 34 Prospect St., East Orange. Estimated cost $40,000.

New York—Elmira Water Light & Railroad Co., has been granted permit to construct electric light plant and distribution system at Big Flats, also gas distribution system at Elmira.

N. Y., Brooklyn—Department of Sanitation, New York, plans treatment of tanks and pumping station in connection with waste disposal plant at Coney Island. Estimated cost to exceed $1,000,000. (Work to proceed by construction of units for immediate use later to be incorporated as part of extensive project.)

N. Y., New York—Department of Sanitation, will receive bids in October for foundations for blower house and probably for superstructure also. Bids soon thereafter on blower house equipment, sewage pumps, etc., at Wards Island. Estimated cost $2,000,000. Total cost $10,-000,000. Fertilizer and storage building maturity later.

N. Y., New York—Report Realty Corp., 3 Bible House, plans alterations to storage building, stores and apartments including boiler room, chimney, etc. Estimated cost $50,000. R. Shutkind, 147 4th Ave., is architect.

Pa., New Castle—New Castle School Board, H. M. Marquis, Secy., 116 East St., will receive bids until June 15 for furnishing and installing new boiler plant at Thaddeus Stevens School, also pump and receiving tank at North St. School, one complete set grates and crushers for No. 1 boilers at Benjamin Franklin Jr. High School.

N. B., St. John—New Brunswick Electric Power Commission, plans extensions through Northumberland county. Estimated cost $750,000.

Ont., Aurora—Town will soon award contract for construction of a sludge sewage disposal plant including pump, air compressor, clarifier equipment, etc. Estimated cost $30,000. James, Proctor & Redfern, 36 Toronto St., Toronto, are engineers. M. L. Andrews, town clerk. Bids June 7.

Que., Montreal—City Executive, will soon receive bids for construction of a waterworks pumping station on St. Helen's Island. Estimated cost $40,000.

Union Soviet Socialist Republics—c/o Amtorg Trading Corp., 261 5th Ave., New York, N. Y., plans construction of steam power plants for block manufacturing, saw-mill and woodworking plants at Karagonda. Work will be done by technical aid contracts; also plans locomotive works at Novocherkassk (North Caucasus). Estimated cost to exceed $1,000,000.

Equipment Wanted

Boilers—Augusta, Me.—State Department of Public Buildings, State House, will soon receive bids for furnishing and installing two coal burning boilers, each 150 hp. also changes in radiators and piping now in place.

Boilers—Brookline, Mass.—Commonwealth of Massachusetts, Metropolitan District Commission, 20 Somerset St., Boston, plans furnishing and installing boilers for Chestnut Hill here. Estimated cost $30,000.

Boilers — Lahore, India — General Manager North Western Railways, will receive bids until June 27 for supply of 25 locomotive boilers for 5 ft. 6 in. gauge and 9 locomotive boilers for 2 ft. 6 in. gauge.

Boiler and Condenser—Springfield, O.—City will soon receive bids for boiler and condenser for proposed addition to present power plant.

Boiler and Equipment—Shelby, O.—City will soon receive bids for a 500 hp. boiler and equipment for municipal power plant.

Boiler, Stoker, etc.—Richland Center, Wis.—City, G. C. Luckey, Clk., will receive bids until June 15 for installation of a 500 hp. water tube boiler, under feed stoker with force draft automatically regulated, soot blowers and breeching in municipal electric light plant.

Condenser, Pumps and Meters — Brooklyn, N. Y., and San Francisco, Calif.—Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will receive bids until June 14 for condenser, pumps and meters for Navy Supply Depots Brooklyn and San Frnacisco.

Electrical Equipment — Philadelphia, Pa. — Department of City Transit, C. C. Davis, Dir., City Hall Annex, will receive bids until June 14 for furnishing, installing and relocating electrical equipment in substations and in subway. Cont. 220.

Hoist — Yakima, Wash. — U. S. Bureau of Reclamation, Denver, Colo., will receive bids until June 16 for motor operated tandem cylinder gate hoist with stems and accessories, also two 20 in. diameter cylinder gates and gate seats for Cle Elum dam, Yakima project here.

Pump — Puget Sound, Wash. — Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will receive bids until June 14 for portable electric pump and spare parts for Navy Yard here.

Pump—Huntington, W. Va.—U. S. Engineer Office, War Department, will receive bids until June 10 for steam driven water pump with all necessary accessories for U. S. Dredge Adams.

Pumping Equipment — Indianapolis, Ind. — Board of Park Commissioners, plans to purchase a new pump, 300 g.p.m. capacity for Garfield Park.